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REVIEW OF THE CURRENT STATUS OF THE SCALLOP FISHERY IN ICNAF DIVISION 5Z

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INTRODUCTION

Caddy (1972 and 1972a) reviewed the current trends in the ICNAF Division 5Z scallop fishery, particularly in relation to the Canadian fishery, and discussed possible management measures. This paper presents a review of the fishery based on United States fishery statistics. An evaluation of effects of minimum size regulations is also presented.

FISHERY TRENDS

Scallop landings reached peak catches of over 15,000 MT of meat weights in the early 1960's. Since then, the harvest has steadily declined, primarily because of the reduction of the U.S. scallop landings. The 1971 catch was 5,281 MT (Table 1). Abundance indices derived from U.S. research vessel cruises from 1961 through 1971 (Table 2) indicated that the early 1960's was a period of peak abundance (Posgay, 1962). The catch decreased by 63 percent from 1961 to 1971, while abundance declined by 80% indicating that fishing mortality has increased.

Changes have also taken place in the size frequency of scallops landed in the commercial fishery. Caddy (1972 and 1972a) reported that average age of first exploitations in Canadian landings has decreased from 5 to 3 years of age. Based on an analysis (see appendix) of samples taken from commercial fishermen.

(Figure 1) it is estimated that the mean age at first capture for the U.S. fleet has decreased from 5 to 4 years of age (Table 3).

The modal size class decreased from 100-110 mm in the 1956-1961 period to 85-95 mm in 1971. A considerable number (8 percent of the total) now are less than 85 mm.

YIELD PER RECRUIT

Merrill and Posgay (1964) estimated the instantaneous mortality (M) of Georges Bank sea scallops to be 0.10. Estimates of Z for the 1958-1962 period (Posgay, 1962, unpublished manuscript on file, Woods Hole Laboratory) range from 0.71 to 0.89. Using growth data available in 1960, Posgay (1962) estimated yield per 10,000 recruits assuming that 3.5 years was the age of first vulnerability to the gear. Maximum yield per recruit was estimated to occur between mean ages of 8.0 and 8.5 years with F from .61 - .79. Posponing age at first capture from 5 to 6 was estimated to increase yield per recruit by 13 to 16 percent.

Mean age at first capture in 1970-71 appears to be between 3 and 4 years based both on the data in this document and that reported by Caddy (1972). Caddy (1972a) estimated total mortality (Z) for 1970-71 for a localized area of the northern edge of Georges Bank to be 1.18. Assuming M to be 0.1, then F would be 1.08. Yield per recruit values were calculated using 3.0 as the age of first vulnerability to capture. Von Bertalanffy's revised growth equation (Posgay, personal communication) incorporating additional length at age data beyond that available for the earlier study was used.

The parameters are compared below:

		Values used in Posgay's 1962 paper	Values used in present calculations
W	-	45.9 gm	46.6 gm
to	-	1	1.5
K	-	.26	.38

The results of the present yield per recruit calculations are presented in Table 4. Maximum yield per recruit would occur at mean age of first harvest between 6.0 and 7.5 years for fishing mortality rate of 0.3 to 1.5. Only very slight gains (about 1 percent) are achieved by delaying harvest beyond age 6. In any case, the maximum yield per recruit is achieved by delaying mean age of first harvest to 7.0 years with an F of 0.9 (213 Kg per 10,000 recruits).

At the estimated current fishing mortality rate (F = 1.1) yield per 10,000 recruits for an age of first harvest of 3.5 years is estimated to be 115 Kg.

Increasing age first harvest to 4.0 would result in a yield of 141 Kg, a 23 percent increase. At 5 years of age the corresponding values are 181 Kg and 57 percent. Effort could be decreased since for ages of first entry of 3.0 to 4.0 years the maximum yield occurs with an F of 0.3 (the minimum examined in this model) and for ages 4.5 to 5.0 maximum occurs for F = 0.4. Even for the age of entry of 7.0 years and F of 0.9, the maximum point, the reduction of effort to F = 0.7 results in only a 1 percent decrease and to F = 0.5 on a 3 percent decrease in yield per recruit.

MANAGEMENT

Caddy (1972) proposed that an increase in cull size could be achieved by establishing a minimum limit on landed average meat weight. The average meat weight was computed for each of the samples from the United States landings in 1970 and 1971 (Table 5). Judged from these samples, an average landed weight of 40 meats per pound (11.4 gms) as proposed by Canada (ICNAF Commissioner's Doc. 72/19) would not affect the current fishing and culling practices of the United States fleet. The only benefit would be to prevent a marked decrease in landed meat weights. The percent weight frequency by shell length of the 1971 United States samples is given in Table 6. The average meat weight for that portion of landings that would have remained if the minimum landed size had been 95 mm, which would raise the average age at first harvest to 5.0 years, is 28.7 gms, or 15.8 meats per pound. If the minimum landed size had been 90 mm, the average weight would have been 27.5 gms (16.5 meats per pound). Changes in the size composition of the population being fished would, of course, alter this figure. However, it is apparent that an average landing limit of about 20 meats per pound would be required to produce the benefits obtained by increasing age of first capture from 4 to 5 years of age.

An alternative management procedure would be to set an absolute limit on the shell size to be kept and monitoring this by measurements of samples of individual meat weights ashore. In Table 6 are presented the average shell lengths for various ages and their expected mean meat weight with accompanying lower confidence limits (see Figure 2 also). For example, presence of scallop meats weighing less than 13.3 gms (the lower 95 percent confidence limit for age 5) would be indicative that scallops smaller than the desired minimum size of 107 mm shell length had been kept.

Research cruise data on the size composition of the populations fished is needed to more clearly evaluate the effect of either of the above management schemes.

In addition to size limit regulations the yield per recruit studies indicate that effort reductions should also be considered, especially if increased catch rates are desired.

APPENDIX

The size composition of the U.S. scallop landings in 1971 was estimated from shell measurements of 56 samples averaging 290 scallops each (Figure 1). These samples were collected throughout the area fished by the U.S. fleet.

The length frequency of the 1971 U.S. catch was estimated by the following procedure: (1) the quarterly percent length frequencies of the pooled samples were calculated for each statistical area; (2) the mean meat weight was computed for the pooled samples for each quarter and statistical area utilizing the length-meat weight seasonal equations estimated by Haynes (1966); (within all quarters except the fourth, a single length-weight equation was used. In the fourth quarter, because of spawning, the values of the conversion parameters were different for the month of October than for the last two months. Therefore, in the fourth quarter the numbers were estimated separately for the two periods and then summed.) (3) The numbers of scallops landed were estimated separately for each quarter and statistical area by dividing the appropriate catch by the corresponding mean meat weight; (4) the length-frequencies of the quarterly catches by area were obtained by applying the values calculated by 1 to the number of scallops landed estimated by 3; (5) these values were then summed over areas and expanded to include the catches from the areas on Georges Bank that were not sampled that quarter; (6) finally, the quarterly values were summed to obtain the estimate for the year.

Ages were assigned to these size categories based on published growth studies (Posgay, 1962) and other unpublished data (J. A. Posgay, personal communication).

LITERATURE CITED

Caddy, J. F. 1972. Some recommendations for conservation of Georges Bank scallop stock. ICNAF Res. Doc. 72/6: 8 p.

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Merrill, A. S. and J. A. Posgay. 1974. Estimating the natural mortality rate of the sea scallop (Placopecten magellanicus) ICNAF Res. Bull (4): 88-98.

Posgay, J. A. 1962. Maximum yield per recruit of sea scallops. ICNAF Res. Doc. 62/73: 20 p.

Table 1. Trends in the scallop landings (M.T. meat weight) from Georges Bank (ICNAF Division 5Z).

Year	Canada M.T.	U. S. M.T.	Total M.T.
1961	4580	10656	15236
1962	5669	9686	15325
1963	5941	7906	13847
1964	5986	6296	12282
1965	4580	1509	6089
1966	4853	901	5754
1967	5034	1229	6263
1968	4807	1050	5857
1969	4354	1343	5697
1970	4036	1421	5457
1971	3946	1335	5281

Table 2. Abundance indices for sea scallop from Georges Bank (ICNAF Division 5Z).

Year	U. S.* Research Cruise	Canada Commercial Catch/Hour (M.T.)
1961	92.6	.1842
1962	99.1	.1002
1963	45.5	.0780
1964	40.0	.0658
1965	33.5	.0567
1966	48.0	.0726
1967	63.0	.0562
1968	44.7	.0505
1969	-	.0491
1970	-	.0376
1971	-	.0381

*Number of scallops over 70 mm per 10,000 ft^2 dragged.

Table 3. Percent frequency distribution of U. S. commercial sea scallop landings (shell length in mm and approximate age in years).

Length	Approximate Age	1956-1962	1971
<-84.9	4	0.3	7.9
85-89.9	4	2.8	11.1
90-94.9	4	7.1	11.2
95-99.9	5	11.7	9.3
100-104.9	5	12.7	9.4
105-109.9	5-6	12.6	10.8
110-114.9	5-6	11.0	8.8
115-119.9	6	9.5	6.3
120-124.9	6	9.1	4.5
125-129.9	6	7.4	3.8
130-134.9	7	6.1	4.2
135-139.9	8	4.6	3.8
140-144.9	9	3.5	3.3
145-149.9	9	1.4	5.5
150-154.9	9	0.1	0.1
155-.59.9	9	0.1	0.0

Table 4. Yield (kg) meat weight per 10,000 recruits with age 3.0 of first availability (T_o) and natural mortality (M) of 0.10.

Mean Age at	Instantaneous Rate of Fishing Mortality												
First Harvest	.03	.04	.05	.06	.07	.08	.09	1.0	1.1	1.2	1.3	1.4	1.5
3.0	143	134	125	116	109	103	97	92	88	84	81	78	76
3.5	158	153	146	139	133	128	123	119	115	112	109	107	104
4.0	171	169	164	159	155	151	147	144	141	138	136	134	132
4.5	181	182	179	176	173	170	167	165	163	161	159	157	156
5.0	188	191	191	189	188	186	184	182	181	179	178	177	175
5.5	192	197	199	199	198	197	196	195	194	193	192	192	191
6.0	194	201	204	205	205	205	205	205	204	204	203	203	202
6.5	194	202	206	208	209	210	210	210	210	210	210	210	210
7.0	192	201	206	209	211	212	213	213	213	214	214	214	214
7.5	189	199	204	208	210	212	213	213	214	214	215	215	215
8.0	185	195	201	205	207	209	211	212	212	213	214	214	214
8.5	180	190	197	201	204	206	207	208	209	210	211	211	212
9.0	175	185	191	196	199	201	203	204	205	206	207	207	208
9.5	169	179	185	190	193	195	197	198	200	201	201	202	203
10.0	163	173	179	184	187	189	191	192	194	195	195	196	197
10.5	156	166	173	177	180	183	184	186	187	188	189	190	190
11.0	150	160	166	170	173	176	178	179	180	181	182	183	184
11.5	144	153	159	163	166	169	171	172	173	174	175	176	177
12.0	138	147	153	157	160	162	164	165	166	167	168	169	170

T (O Length) ------ 1.50
T (M = Z; F = O) -- 3.00
T (Maximum) ------- 17.00
K - Value --------- .3800
W - Infinity ------ 46.60

Table 5. Frequency distribution of average meat weights in samples of U. S. commercial scallop fishing trips.

Meats/lbs.	1970		1971	
	No. of samples	%	No. of samples	%
>-44.9	2	4.4	1	1.8
40-44.9	8	17.8	3	5.4
35-39.9	4	8.9	5	8.9
30-34.9	6	13.3	5	8.9
25-29.9	2	4.4	11	19.6
20-24.9	16	35.6	10	17.9
15-19.9	7	15.6	21	37.5
10-14.9				
	45	100.0	56	100.0

Table 6. Age-length-meat weight relationships.

Age at Harvest	Cull Length (mm)	Mean Weight (gms)	Lower confidence limits on meat weights .9500	.9900	.9995
3.0	63	4.0	2.8	2.4	2.0
4.0	89	11.0	7.7	6.7	5.5
5.0	107	18.9	13.3	11.5	9.0
6.0	119	25.8	18.2	15.8	12.9
7.0	127	31.3	22.1	19.1	15.6
8.0	133	35.9	25.3	21.9	17.9

Table 7. Percent weight composition of U. S. commercial sea scallop landings in 1971.

Length	Approximate Age	Weight at Length* grams	no/pound	% Weight Frequency
80-84.9	4	8.0	56.7	3.2
85-89.9	4	9.5	47.2	5.3
90-94.9	4	11.3	40.2	6.3
95-99.9	5	13.3	34.1	6.2
100-104.9	5	15.5	29.4	7.3
105-109.9	5-6	17.9	25.5	9.7
110-114.9	5-6	20.5	22.1	9.0
115-119.9	6	23.4	19.5	7.4
120-124.9	6	26.5	17.2	6.0
125-129.9	6	29.9	15.2	5.7
130-134.9	7	33.5	13.6	7.0
135-139.9	8	37.5	12.1	7.1
140-144.9	9	41.7	10.9	6.9
145-149.9	9	46.3	9.8	12.7
150-154.9	9	51.1	8.9	0.3
155-159.9	9	56.3	8.1	0.0

*Estimated by the equation given by Haynes (1966) for all months combined.

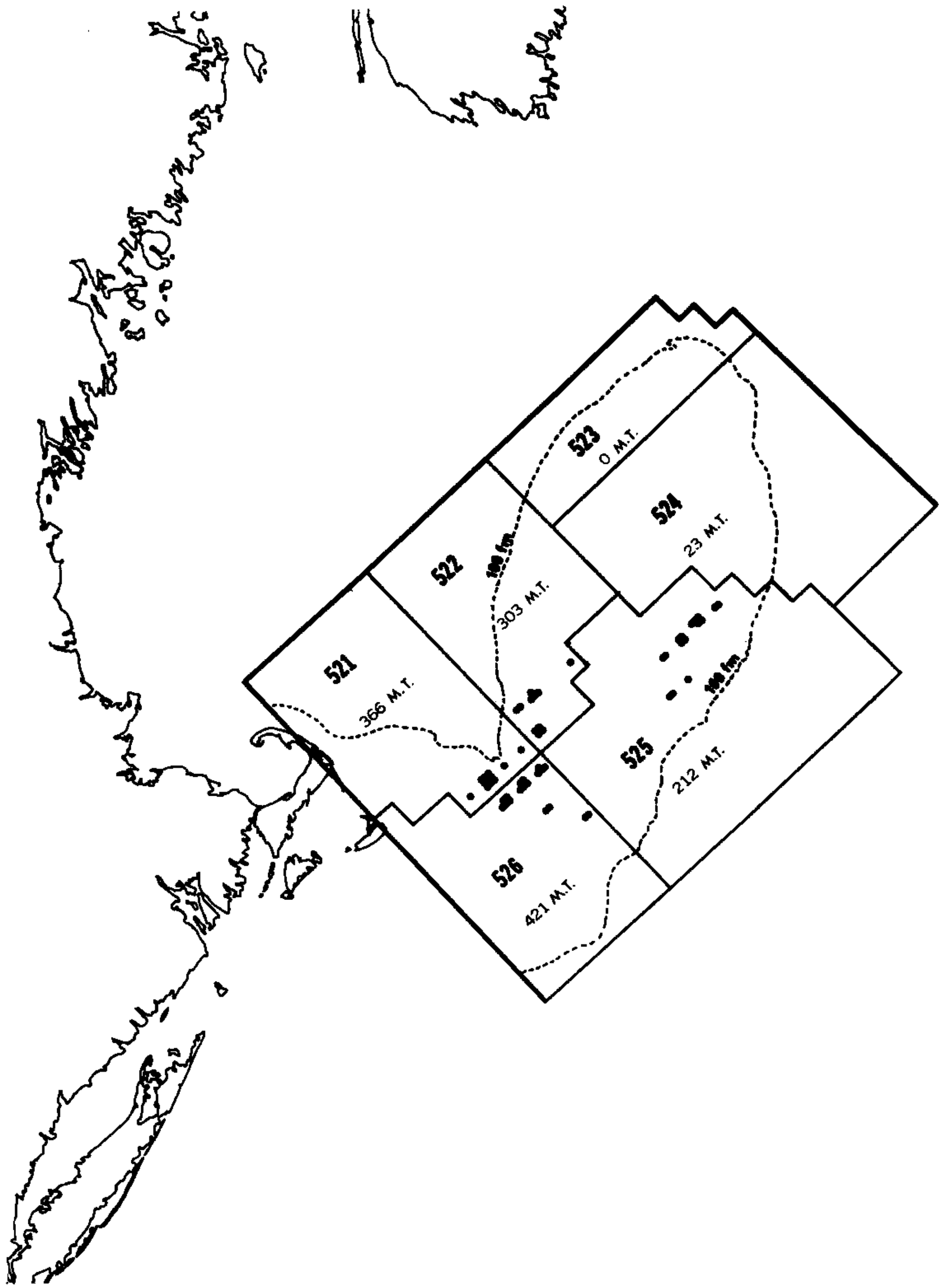

Figure 1. -- Distribution of 1971 scallop samples and total U.S. catch by statistical area.

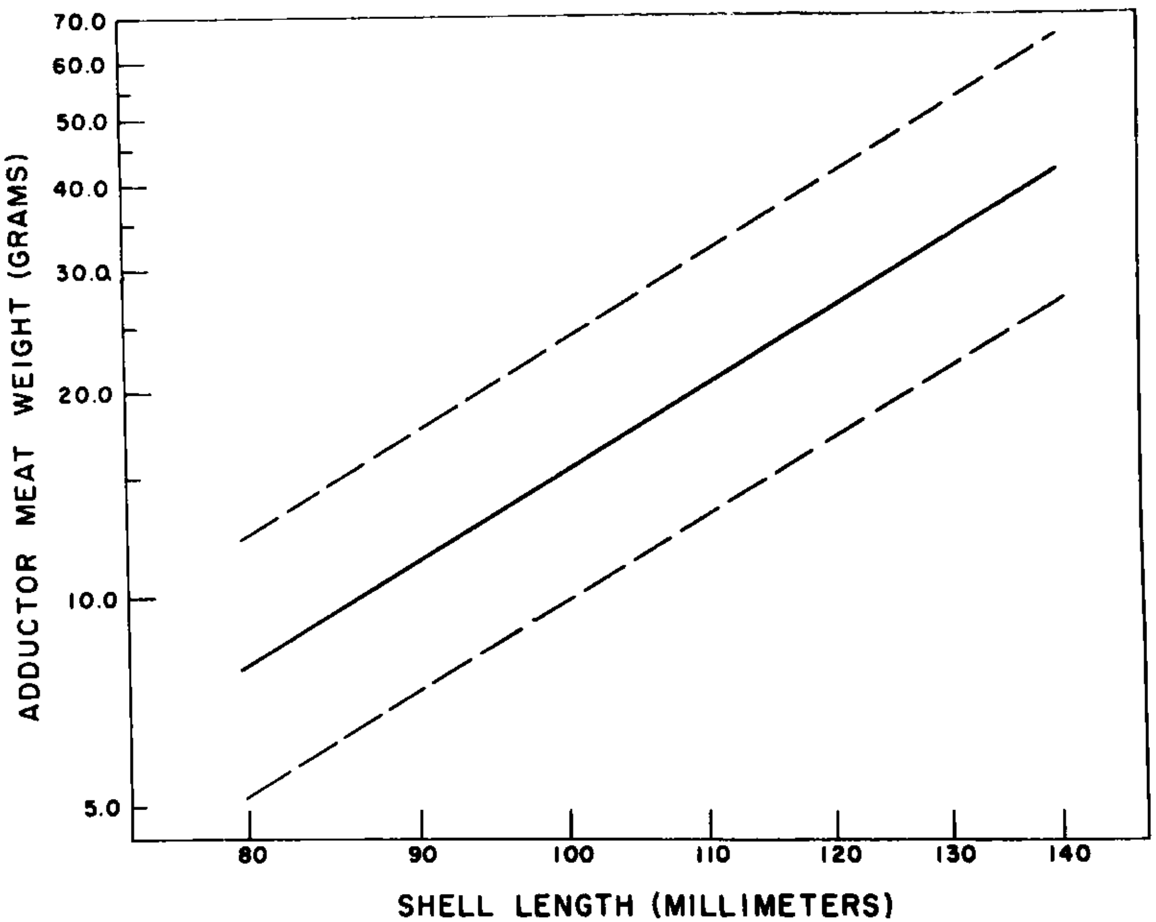

Figure 2. -- Relationship (Haynes, 1966) between shell length and meat weights for sea scallop from Georges Bank (95% confidence belt given).