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Minimum Trawlable Biomass Estimates of Arctic Cod (*Boreogadus saida*) in
NAFO Divisions 2G and 2H from Post-Stratified Groundfish Surveys

by

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INTRODUCTION

The Arctic cod (*Boreogadus saida*) is circumpolar in its distribution and in the eastern Canadian area extends along the Labrador coast to the northwestern Gulf of St. Lawrence (Leim and Scott, 1966) and to the northern Grand Bank with occasional occurrences on the eastern and southern Grand Bank (Lear 1979). There have been no attempts to describe the abundance of Arctic cod off the northern Labrador coast (NAFO Divisions 2G and 2H) up to the present. An absolute estimate of Arctic cod abundance is difficult to obtain, bearing in mind their distribution in the water column ranging from surface waters to depths greater than 900 m (Walters 1955).

During the autumn of 1978, 1979, and 1981, the Canadian research vessel GADUS ATLANTICA conducted surveys for groundfish in NAFO Divisions 2G and 2H. The line transect surveys were conducted across the following depth ranges: 101-200, 201-300, 301-400, 401-500, 501-750, 751-1000, and greater than 1000 m. Since the positions of the depth zones in these areas were rather unreliable, the positions of many of the fishing stations in the 1978 survey were changed from the original planned position in order to find the required depth range. Each subsequent survey was planned according to the successful fishing positions determined from the results of the 1978 survey with additional fishing stations inserted where time permitted. The fixed point stations for the three years were later assigned to depth strata when the survey area was post stratified.

MATERIALS AND METHODS

Stratification charts were constructed using the depth contours of the Fisheries Chart Nos. 8046 and 8047 of the Canadian Hydrographic Service. Each NAFO Division was divided into three zones with a stratum number assigned to each depth range for each zone (Fig. 1, 2). The area of each stratum was then determined using a planimeter and subsequently each stratum area was broken down into trawlable units. A trawlable unit was defined as the area swept by a trawl with a 45' wing spread towed a distance of 1.8 nautical miles, i.e. the distance usually towed per 30 minute fishing set. These calculations are shown in Table 1 for Div. 2G and Table 4 for Div. 2H.

For each survey, the fishing sets were assigned to the stratum in which it occurred and where the fishing depth did not agree with stratum in which the position occurred it was assigned to the nearest stratum containing the fishing depth. Estimates of biomass by stratum, zone, and depth range were then calculated in the usual way. Variances and confidence intervals were not presented since the calculations were based upon fixed and not random stations. However, the estimates of biomass should be relative indicators of stock size throughout the area if it is assumed that the vertical and horizontal distributions are similar for the 3 years.

RESULTS AND DISCUSSION

Biomass estimates of Arctic cod calculated by stratum and year are presented in Tables 1-3 for Div. 2G for 1978, 1979, and 1981 respectively. For strata fished, the estimates ranged from 583,605 t in 1978 to 100,761 t in 1979, and decreased further to

46,636 t in 1981. The greatest relative abundance, as determined from bottom otter trawling, occurred in Stratum 7, on the central part of Saglek Bank (101-200 m) during 1978, 1979, and 1981 (Table 7). Biomass estimates in other strata, with the exception of stratum 13 in 1978 (102,000 t), were low or were zero quantities. No Arctic cod were caught deeper than 400 m in 1979 or deeper than 300 m in 1979 and 1981 within NAFO Division 2G.

For Division 2H the biomass estimates by stratum (Tables 4-6) were 551 t in 1978, 3,515 t in 1979, and 643 t in 1981. The Arctic cod were mainly concentrated within the 101-200 m strata on Main Bank (Strata 1 and 7) and on the northern part of Makkovik (Stratum 13) (Table 8). Catches in other strata were small (Strata 2, 8 and 14) or zero quantities. There were occasional catches of Arctic cod in the 501-700 m stratum (17) but most were from depths less than 400 m.

The estimates derived from otter trawl surveys represent only the minimum trawlable biomass since the otter trawl samples only the bottom, although occasionally it may sample Arctic cod in the upper water column. During the 1978 survey it was observed that Arctic cod, in addition to their being distributed near the bottom, were also in dense schools from the bottom up to 10-50 m above the bottom (Lear 1979). In these instances the otter trawl takes only a very narrow slice of the school and the water volume in which the Arctic cod are distributed relative to the volume sampled by the trawl is large. In some cases the otter trawl could possibly pass under a large concentration of Arctic cod and catch only a few individuals or none at all.

Possibly a better sampling method for biomass estimates of Arctic cod would be the use of acoustics as used for biomass estimates of capelin (Miller 1984; Miller and Carscadden, 1984) combined with some otter trawl sets mainly in the shallower strata (101-200 and 201-300 m depths).

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Table 1. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2G for 1978.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	1,136	85,414	3	110.48	9,437
2	201-300	910	48,421	2	0.12	8
3	301-400	705	53,008	1	0.00	0
4	401-500	1,108	83,308	-	-	-
5	501-750	1,625	122,180	-	-	-
6	751-1000	138	10,376	-	-	-
Total						9,445
7	101-200	4,022	302,406	10	1559.45	471,587
8	201-300	975	73,308	4	0.00	0
9	301-400	160	12,030	2	0.00	0
10	401-500	103	7,744	3	0.00	0
11	501-750	105	7,895	-	-	-
12	751-1000	88	6,617	-	-	-
Total						471,587
13	101-200	3,340	251,128	13	408.06	102,475
14	201-300	1,943	146,090	10	0.67	98
15	301-400	133	10,000	1	0.00	0
16	401-500	91	6,842	-	-	-
17	501-750	103	7,744	1	0.00	0
18	751-1000	231	17,368	-	-	-
Total						102,573
Division Total						583,605

Table 2. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2G for 1979.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	1,136	85,414	2	1.36	116
2	201-300	910	48,421	2	0.09	6
3	301-400	705	53,008	2	0.03	2
4	401-500	1,108	83,308	-	-	-
5	501-750	1,625	122,180	5	0.00	0
6	751-1000	138	10,376	-	-	-
Total						124
7	101-200	4,022	302,406	10	327.19	98,944
8	201-300	975	73,308	6	0.08	6
9	301-400	160	12,030	1	0.00	0
10	401-500	103	7,744	2	0.00	0
11	501-750	105	7,895	1	0.00	0
12	751-1000	88	6,617	-	-	-
Total						98,950
13	101-200	3,340	251,128	13	5.34	1,341
14	201-300	1,943	146,090	9	2.37	346
15	301-400	133	10,000	1	0.00	0
16	401-500	91	6,842	2	0.00	0
17	501-750	103	7,744	3	0.00	0
18	751-1000	231	17,368	-	-	-
Total						1,687
Division Total						100,761

Table 3. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2G for 1981.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	1,136	85,414	1	0.10	9
2	201-300	910	68,421	2	0.15	10
3	301-400	705	53,008	2	0.00	0
4	401-500	1,108	83,308	1	0.00	0
5	501-750	1,625	122,180	4	0.00	0
6	751-1000	138	10,376	-	-	-
Total						19
7	101-200	4,022	302,406	10	153.95	46,555
8	201-300	975	73,308	4	0.03	2
9	301-400	160	12,030	2	0.00	0
10	401-500	103	7,744	2	0.00	0
11	501-750	105	7,895	-	-	-
12	751-1000	88	6,617	-	-	-
Total						46,557
13	101-200	3,340	251,128	8	0.06	15
14	201-300	1,943	146,090	8	0.31	45
15	301-400	133	10,000	1	0.00	0
16	401-500	91	6,842	2	0.00	0
17	501-750	103	7,744	4	0.00	0
18	751-1000	231	17,368	-	-	-
Total						60
Division Total						46,636

Table 4. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2H for 1978.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	2,307	173,459	7	1.98	343
2	201-300	445	33,459	3	0.27	9
3	301-400	133	10,000	1	0.00	0
4	401-500	62	4,662	-	-	-
5	501-750	85	6,391	-	-	-
6	751-1000	103	7,744	-	-	-
Total						352
7	101-200	1,791	134,662	5	0.68	92
8	201-300	1,066	80,150	3	0.20	16
9	301-400	1,019	76,617	6	0.02	2
10	401-500	584	43,910	4	0.01	1
11	501-750	424	31,880	1	0.00	0
12	751-1000	569	42,782	2	0.00	0
Total						111
13	101-200	1,281	96,316	4	0.58	54
14	201-300	681	51,203	5	0.63	32
15	301-400	421	31,654	2	0.00	0
16	401-500	265	19,925	-	-	-
17	501-750	981	73,759	5	0.03	2
18	751-1000	195	14,662	-	-	-
Total						88
Division Total						551

Table 5. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2H for 1979.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	2,307	173,459	7	11.03	1,913
2	201-300	445	33,459	4	0.44	15
3	301-400	133	10,000	2	0.00	0
4	401-500	62	4,662	1	0.00	0
5	501-750	85	6,391	2	0.00	0
6	751-1000	103	7,744	1	0.00	0
Total						1,928
7	101-200	1,791	134,662	8	0.89	120
8	201-300	1,066	80,150	5	0.03	2
9	301-400	1,019	76,617	9	0.02	2
10	401-500	584	43,910	7	0.00	0
11	501-750	424	31,880	3	0.00	0
12	751-1000	569	42,782	1	0.00	0
Total						124
13	101-200	1,281	96,316	6	15.13	1,457
14	201-300	681	51,203	4	0.06	3
15	301-400	421	31,654	4	0.08	3
16	401-500	265	19,925	2	0.00	0
17	501-750	981	73,759	7	0.00	0
18	751-1000	195	14,662	-	-	-
Total						1,463
Division Total						3,515

Table 6. Minimum trawlable biomass estimates (t) of Arctic cod by stratum for Division 2H for 1981.

Stratum	Depth range (m)	Area (sq. mi.)	Trawlable units	No. sets	Average wt./set (kg)	Est. biomass (t)
1	101-200	2,307	173,459	7	2.21	383
2	201-300	445	33,459	4	0.25	8
3	301-400	133	10,000	2	0.00	0
4	401-500	62	4,662	1	0.00	0
5	501-750	85	6,391	2	0.00	0
6	751-1000	103	7,744	-	-	-
Total						391
7	101-200	1,791	134,662	8	0.70	94
8	201-300	1,066	80,150	6	0.45	36
9	301-400	1,019	76,617	9	0.01	1
10	401-500	584	43,910	10	0.01	1
11	501-750	424	31,880	5	0.00	0
12	751-1000	569	42,782	1	0.00	0
Total						132
13	101-200	1,281	96,316	7	1.04	100
14	201-300	681	51,203	5	0.24	12
15	301-400	421	31,654	4	0.25	8
16	401-500	265	19,925	3	0.00	0
17	501-750	981	73,759	8	0.00	0
18	751-1000	195	14,662	-	-	-
Total						120
Division Total						643

Table 7. Minimum trawlable biomass estimates (t) of Arctic cod by Stratum for NAFO Division 2G during 1978, 1979, and 1981.

Zone	Stratum	Depth range (m)	1978	1979	1981
1	1	101-200	9,437	116	9
	2	201-300	8	6	10
	3	301-400	0	2	0
	4	401-500	-	-	0
	5	501-750	-	0	0
	6	751-1000	-	-	-
	Total		9,445	124	19
2	7	101-200	471,587	98,944	46,555
	8	201-300	0	6	2
	9	301-400	0	0	0
	10	401-500	0	0	0
	11	501-750	-	0	-
	12	751-1000	-	-	-
	Total		471,587	98,950	46,557
3	13	101-200	102,475	1,341	15
	14	201-300	98	346	45
	15	301-400	0	0	0
	16	401-500	-	0	0
	17	501-750	0	0	0
	18	751-1000	-	-	-
	Total		102,573	1,687	60
Division	Total		583,605	100,761	46,636

Table 8. Minimum trawlable biomass estimates (t) of Arctic cod by Stratum for NAFO Division 2H during 1978, 1979, and 1981.

Zone	Stratum	Depth range (m)	1978	1979	1981
1	1	101-200	343	1,913	383
	2	201-300	9	15	8
	3	301-400	0	0	0
	4	401-500	-	0	0
	5	501-750	-	0	0
	6	751-1000	-	0	-
	Total		352	1,928	391
2	7	101-200	92	120	94
	8	201-300	16	2	36
	9	301-400	2	2	1
	10	401-500	1	0	1
	11	501-750	0	0	0
	12	751-1000	0	0	0
	Total		111	124	132
3	13	101-200	54	1,457	100
	14	201-300	32	3	12
	15	301-400	0	3	8
	16	401-500	-	0	0
	17	501-750	2	0	0
	18	751-1000	-	-	-
	Total		88	1,463	120
Division	Total		551	3,515	643

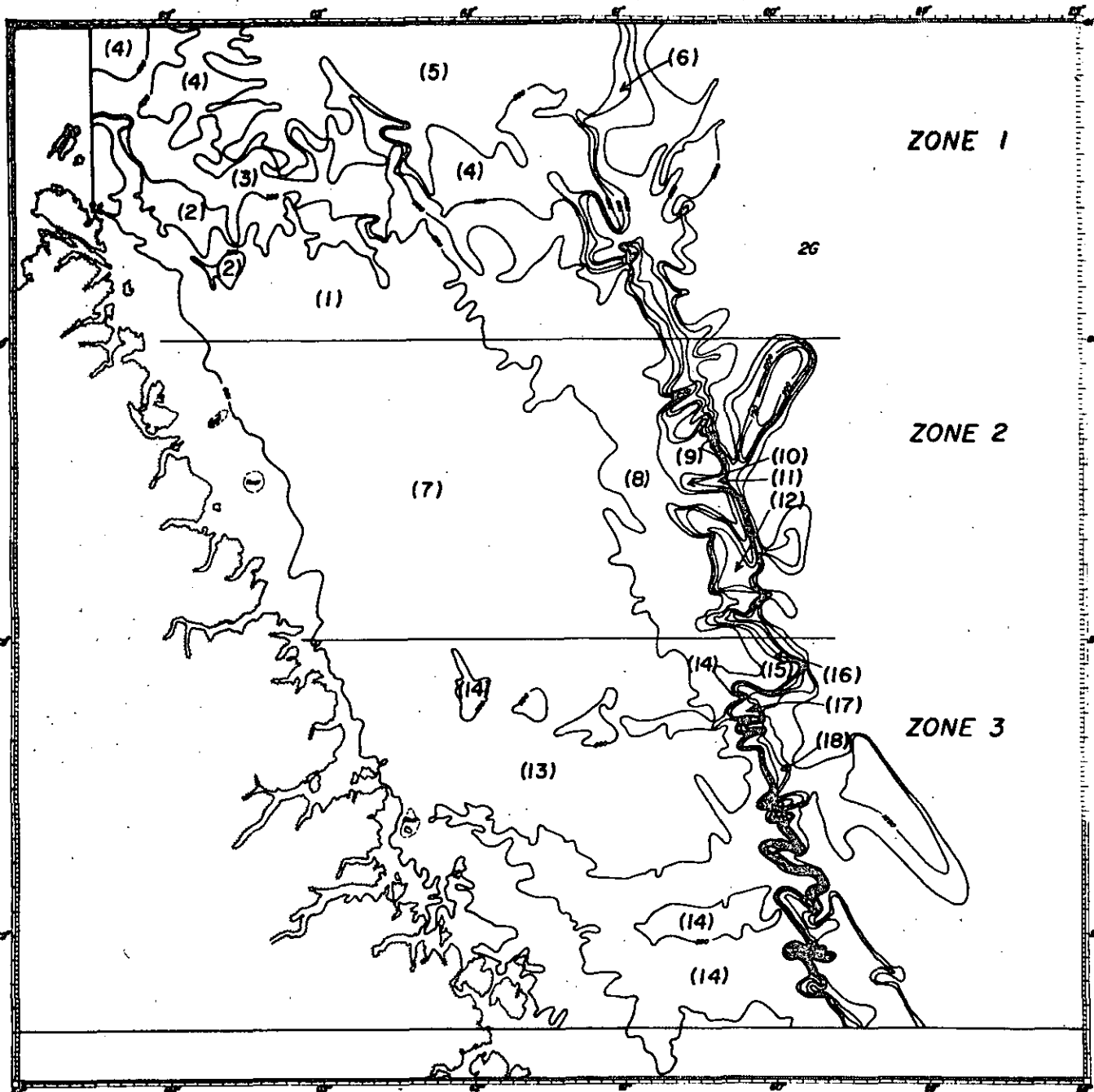


Fig. 1. Stratification Chart for NAFO Division 26.

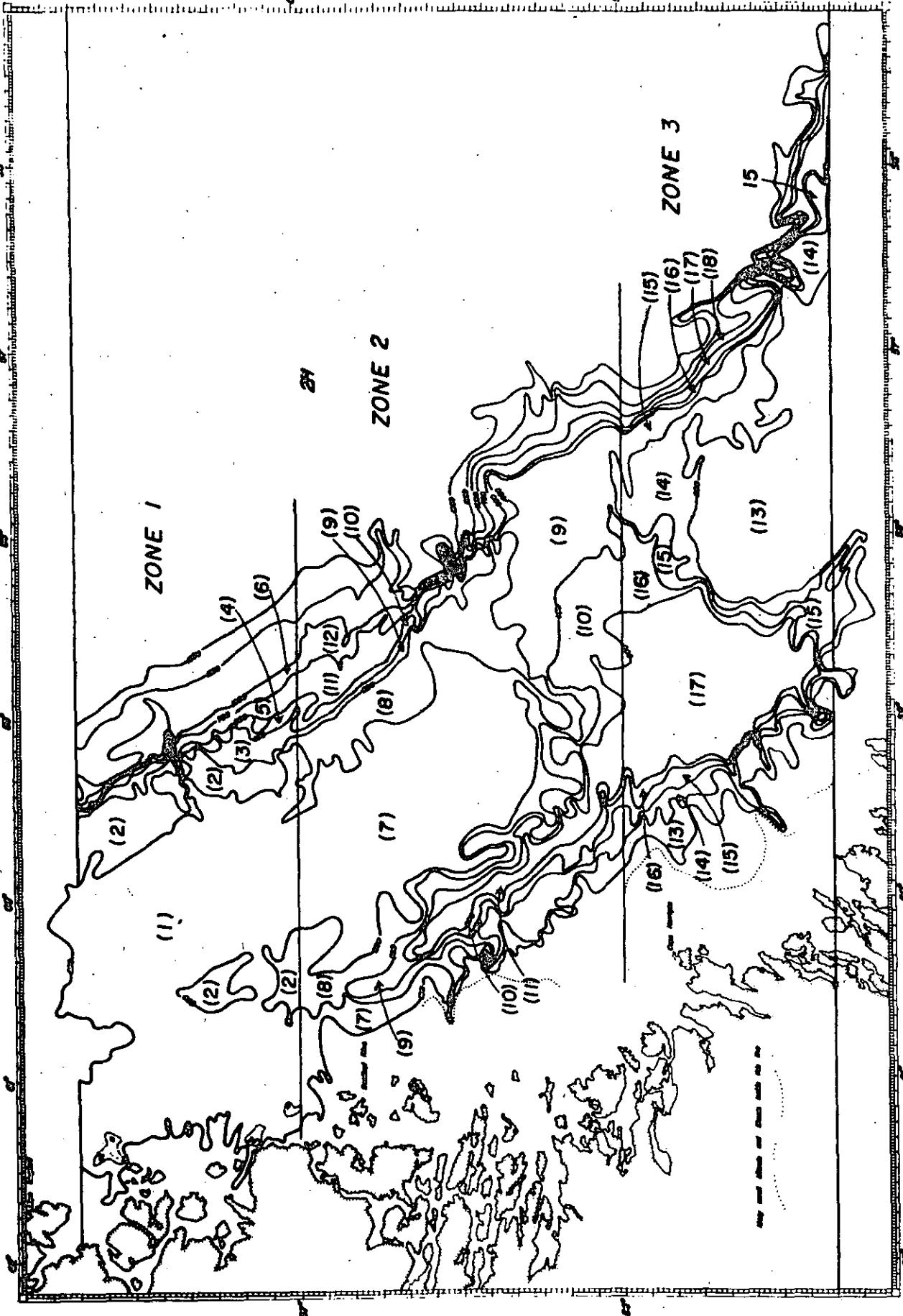


Fig. 2. Stratification Chart for NAFO Division 2H.