

Northwest Atlantic



Fisheries Organization

Serial No. N2417

NAFO SCR Doc. 94/47

SCIENTIFIC COUNCIL MEETING - JUNE 1994

Analysis of Data Collected by Observers During the
Greenland halibut Otter Trawl Fisheries in Subarea 0 During 1988-1993

by

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Introduction

With the decline in 'traditional' groundfish resources off Canada's northeast coast during the late 1980s, interest increased in the deepwater resources further to the north. Beginning in the late 1980s, catches of Greenland halibut from NAFO Subarea 0 (primarily Div. 0B) began to increase. During 1988 and 1989, catches were taken primarily by long lines, but catches by otter trawlers gradually increased during the 1990s. Although some of this otter trawl fishery was prosecuted by Canadian vessels, much of the catch was taken by non-Canadian vessels fishing the Canadian quota under contract arrangements.

There has been extensive Observer coverage of this developing fishery. All trawlers carried observers, and detailed set by set information has been collected by them. In this paper, we present some of the information pertaining to catch rates and catch at age collected by these observers.

Materials and Methods

Catch and effort data were available set by set for 1990-1993 inclusive. The data were summarized by trip and month, then analysed using a multiplicative model (Gavaris 1980) to derive a standardized catch rate (t/hour) series. Categories of country, tonnage class, month and year were included. Because of patterns in the residuals, catches and effort of < 10 units were removed, as were countries, tonnage classes and months with < 5 data points.

Positional data were available for each fishing set. The effort and catch rate data were aggregated by 15' minute squares and plotted by year to examine for possible changes in fishing patterns over time.

Length frequency data as well as otoliths were also collected by the Canadian observers. These data were combined to obtain annual estimates of catch-at-age for 1989-1993.

Results

Catch Rates

The regression in the multiplicative analysis was significant, explaining 77% of the observed variation in the data (Table 1). The trend in standardized catch rates (Figure 1) is fairly constant from 1990-1991, but declined significantly in 1992. There was a further decline in 1993.

Distribution of Effort and Catch Rates

In all years, effort was centered along the 1000 m contour (Figure 2), although there was some extension both shallower and deeper in 1993. During 1990 and 1991, effort generally extended no further north than about 63° N, but another area of fishing developed near 64° N in 1992 and 1993.

In 1990 and 1991, catch rates were higher on average around 1000 m and 62° N (Figure 3). In 1992, catch rates in this area appeared to decline, and a larger area of acceptable catch rates was found further north. The fishery continued in the more northern area in 1993, although catch rates generally declined. Catch rates appeared to be best in the deeper regions of the more southern area, although fishing effort in this same area was relatively low.

Catch and Weights-at-Age

The estimated catch-at-age (Table 2a, Figure 4) indicates that older fish dominated during 1988 and 1989 compared to the more recent years. This is primarily related to the earlier catches being predominantly taken by longlines whereas after 1990, a greater proportion was taken by trawlers which are known to catch smaller sizes. From 1991 through 1993, there has been almost no change in the age distribution of the catch. There do not appear to be any trends in the weights-at-age over time (Table 2b).

References

- Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. *Can. J. Fish. Aquat. Sci.* 37: 2272-2275.

TABLE 1: REGRESSION OF MULTIPLICATIVE MODEL.

MULTIPLE R..... .875
 MULTIPLE R SQUARED..... .765

ANALYSIS OF VARIANCE.

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.009E2	3.009E2	
REGRESSION	18	9.630E1	5.350E0	99.861
COUNTRY	7	4.193E1	5.990E0	111.808
TONNAGE	3	9.824E-1	3.275E-1	6.112
MONTH	5	4.288E0	8.576E-1	16.008
YEAR	3	2.647E0	8.823E-1	16.468
RESIDUALS	551	2.952E1	5.358E-2	
TOTAL	570	4.268E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
COUNTRY	20	INTERCEPT	-1.161	0.045	570
TONNAGE	6				
MONTH	9				
YEAR	90				
COUNTRY	2	1	0.712	0.089	12
	3	2	0.678	0.062	36
	5	3	0.632	0.052	68
	14	4	0.643	0.109	28
	15	5	0.954	0.039	112
	32	6	-0.035	0.096	15
	34	7	0.305	0.064	219
TONNAGE	4	8	-0.287	0.107	28
	5	9	-0.176	0.128	5
	7	10	0.095	0.033	159
MONTH	7	11	0.041	0.040	50
	8	12	0.035	0.030	117
	10	13	-0.053	0.030	124
	11	14	0.156	0.036	103
	12	15	0.351	0.054	39
YEAR	91	16	0.043	0.035	147
	92	17	-0.154	0.052	187
	93	18	-0.316	0.057	102

PREDICTED CATCH RATE

YEAR	LN TRANSFORM		RETRANSFORMED	
	MEAN	S.E.	MEAN	S.E.
1990	-1.1612	0.0020	0.321	0.014
1991	-1.1180	0.0014	0.336	0.013
1992	-1.3154	0.0044	0.275	0.018
1993	-1.4776	0.0047	0.234	0.016

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.054

TABLE 2: CATCH-AT-AGE (000s) AND WEIGHT-AT-AGE BY VESSELS FISHING THE CANADIAN QUOTA OF GREENLAND HALIBUT IN SUBAREA 0 (MAINLY DIV. 0B).

A) CATCH-AT-AGE

Age	Year					
	1988	1989	1990	1991	1992	1993
1						
2						
3						
4					8	1
5			2	16	40	30
6			55	238	468	338
7	1	2	412	1,364	1,856	1,696
8	5	9	1,434	2,162	2,446	1,965
9	9	11	1,226	1,213	1,508	906
10	18	13	685	512	587	482
11	24	14	346	200	194	159
12	31	30	190	140	131	90
13	39	32	189	110	107	51
14	30	34	115	57	54	22
15	24	20	65	34	21	13
16	8	8	14	5	5	4
17	1		2		1	
18						
Total	190	173	4,735	6,051	7,426	5,757
Catch (t)	1,024	907	9,820	9,854	11,039	7,613

B) WEIGHT-AT-AGE (KG)

Age	Year					
	1988	1989	1990	1991	1992	1993
1						
2						
3						
4					0.196	0.175
5			0.376	0.356	0.333	0.302
6			0.562	0.554	0.572	0.526
7	0.818	0.785	0.813	0.820	0.829	0.810
8	1.200	1.076	1.098	1.143	1.162	1.170
9	1.781	1.585	1.533	1.632	1.692	1.716
10	2.446	2.149	2.122	2.333	2.420	2.357
11	3.244	2.878	2.961	3.390	3.390	3.264
12	4.169	3.822	3.916	4.364	4.309	4.266
13	5.136	4.929	4.986	5.610	5.555	5.519
14	6.317	6.265	6.275	7.022	7.176	6.803
15	7.736	7.825	8.049	8.669	8.786	7.976
16	9.511	9.883	10.354	10.849	10.269	9.786
17	10.772		12.804		11.951	
18						

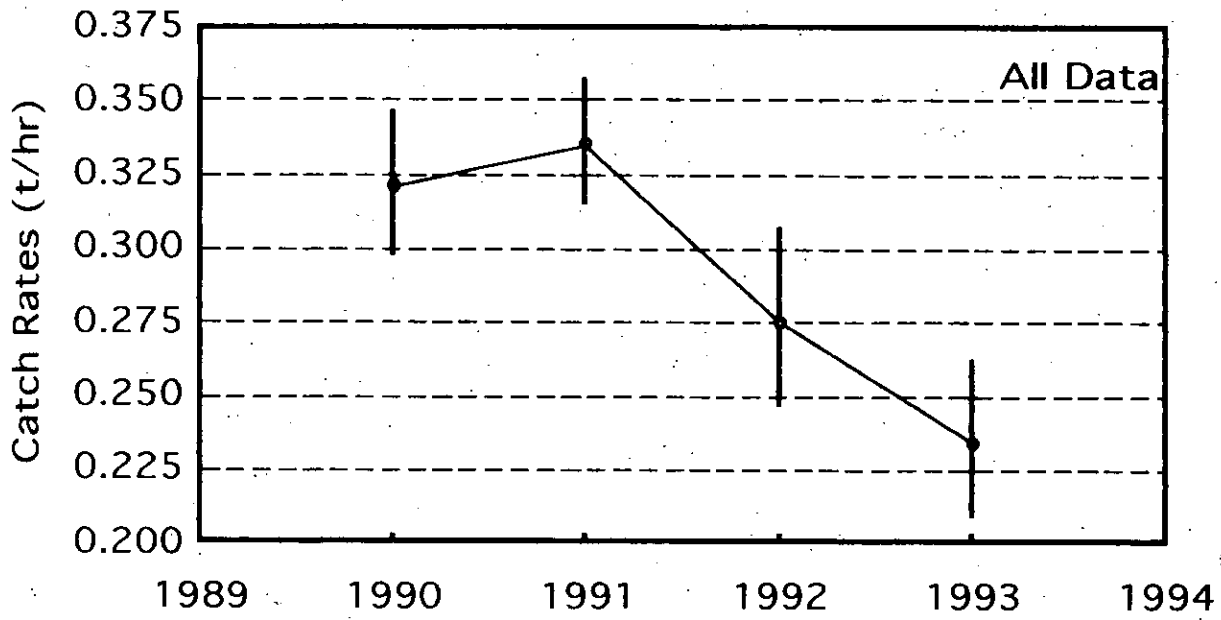


FIGURE 1: STANDARDIZED CATCH RATES FROM MULTIPLICATIVE ANALYSIS SHOWING 95% CONFIDENCE LIMITS.

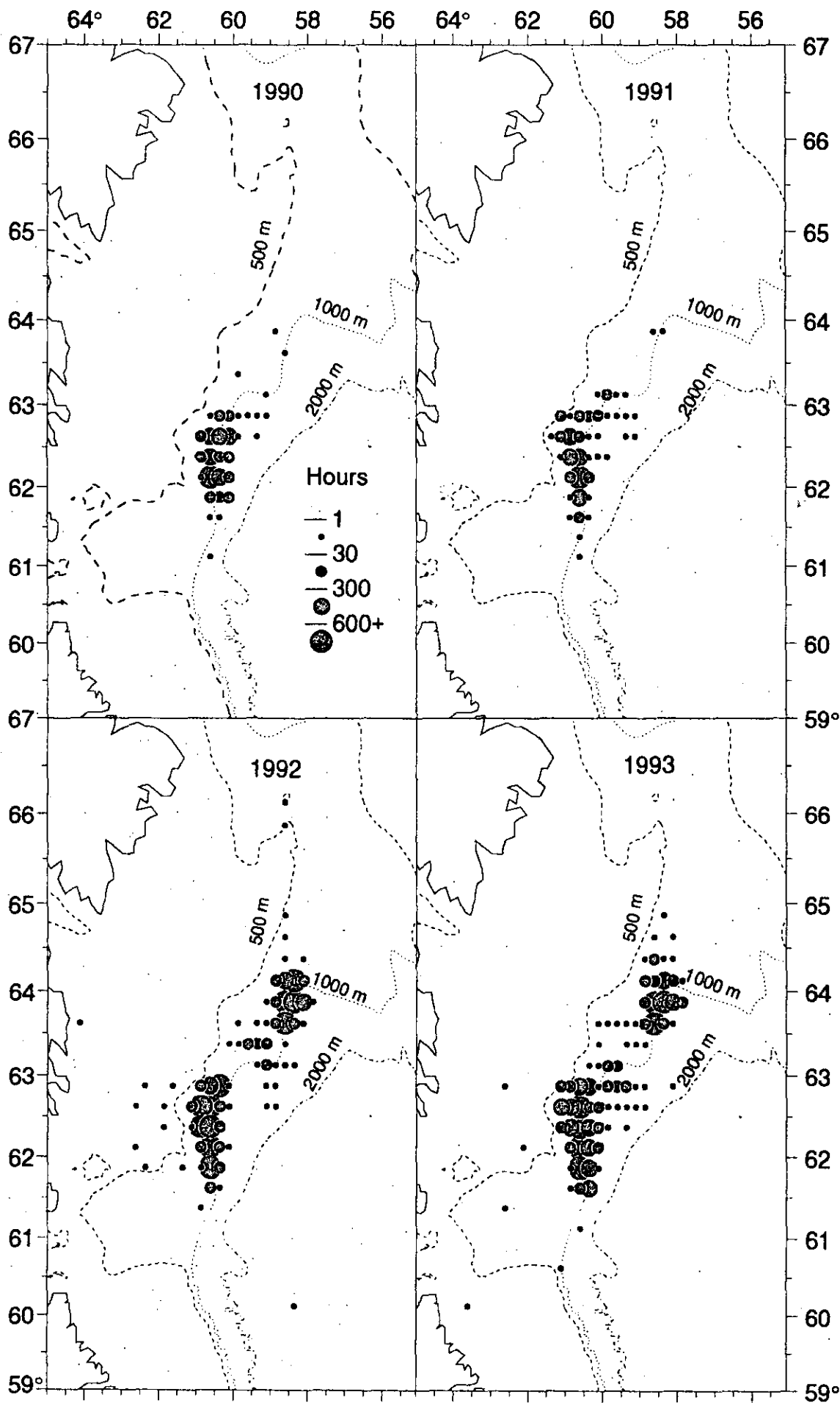


Figure 2: Distribution of trawling effort (hours) by 15' square in SA 0.

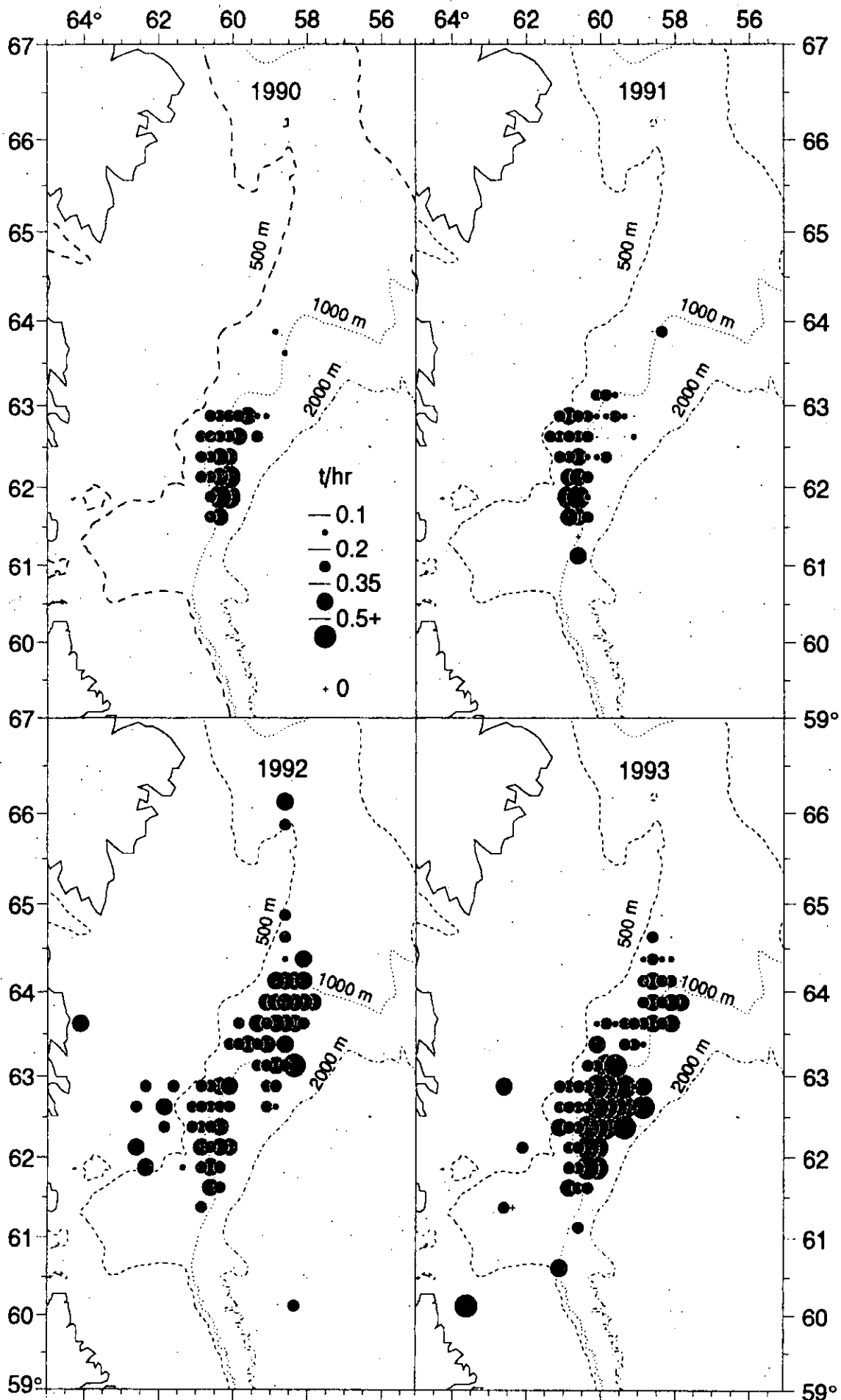


Figure 3: Distribution of trawler catch rates (t/hr) in Subarea 0.

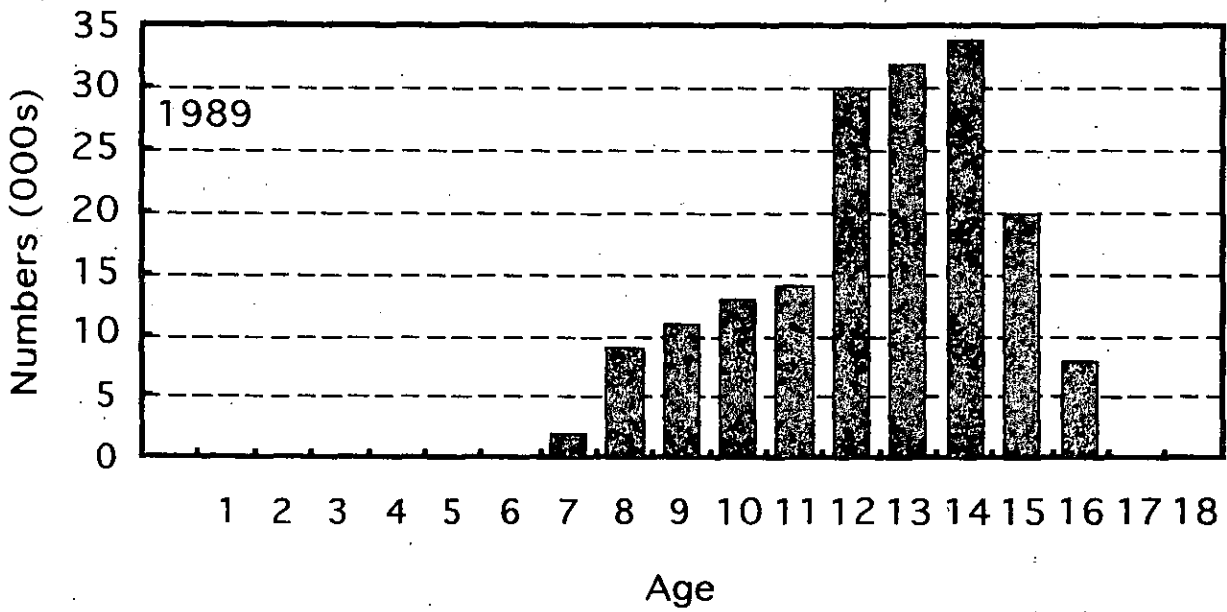
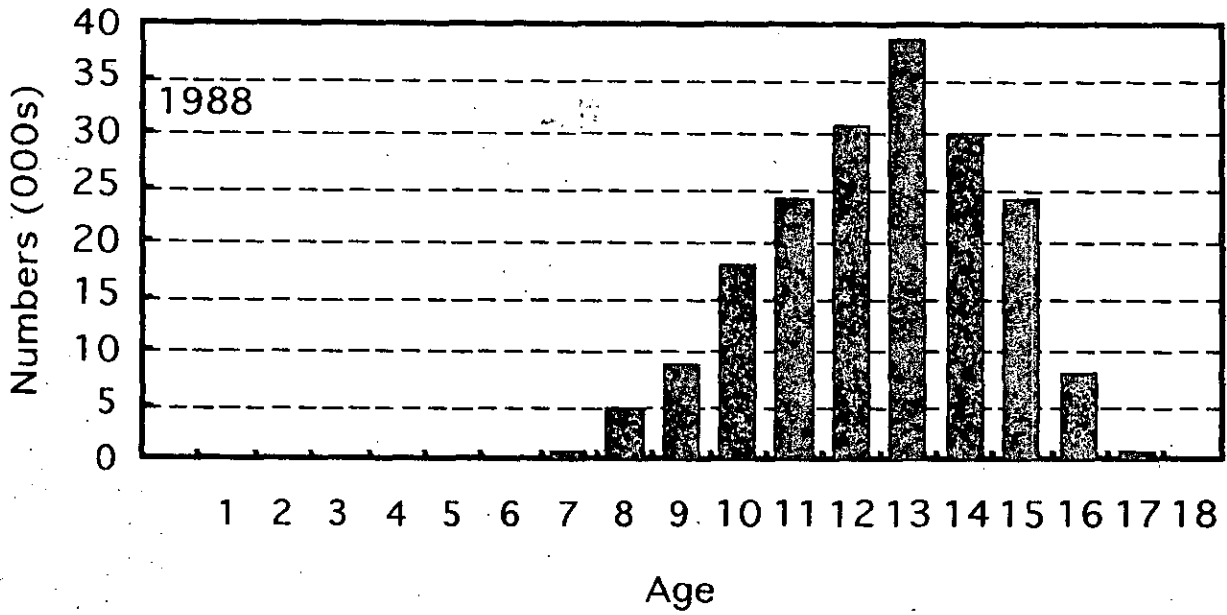


FIGURE 4: CATCH-AT-AGE IN THE COMMERCIAL FISHERIES IN SUBAREA 0 (MAINLY DIV. 0B) DURING 1989-1993.

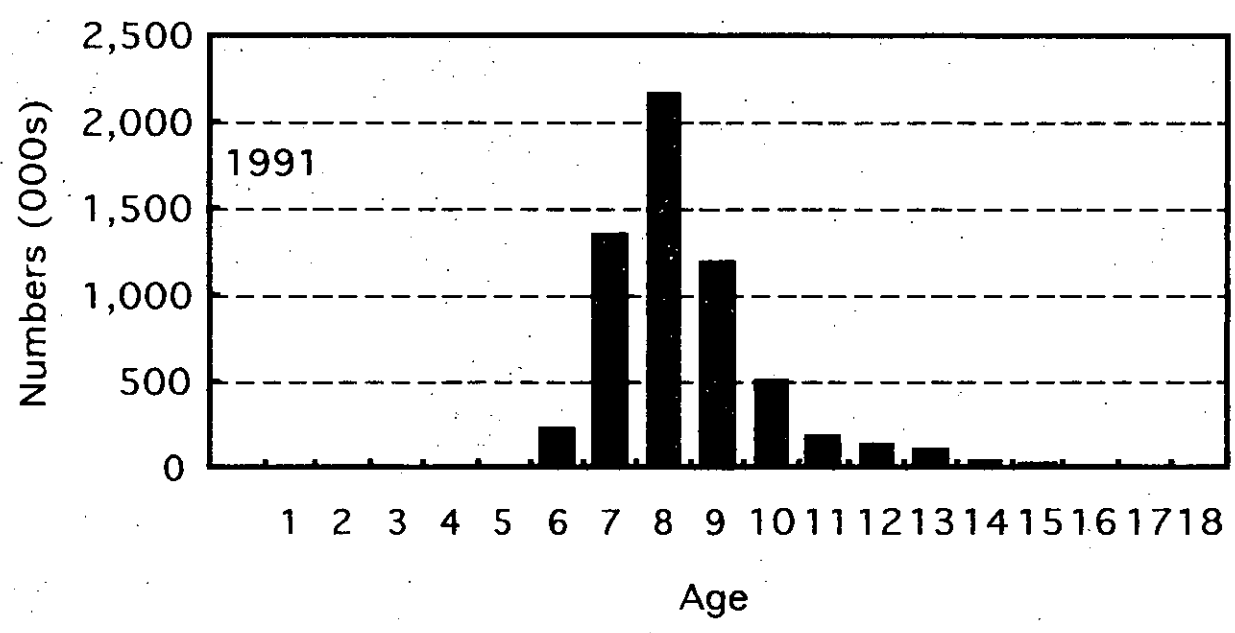
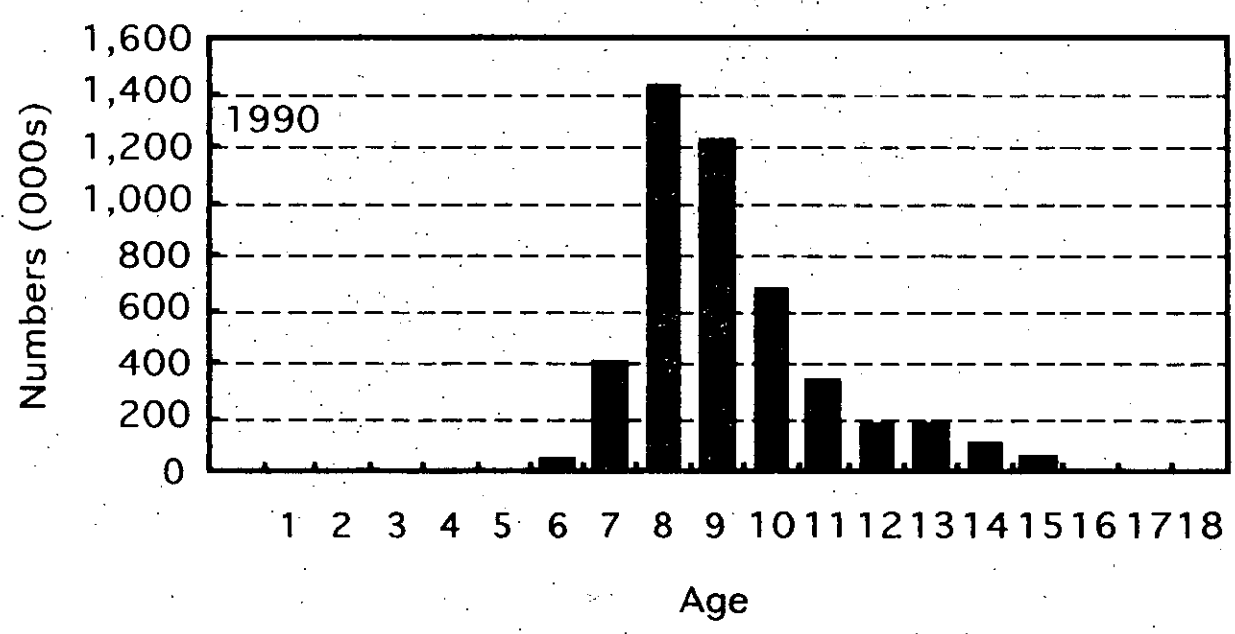


FIGURE 4: CONTINUED.

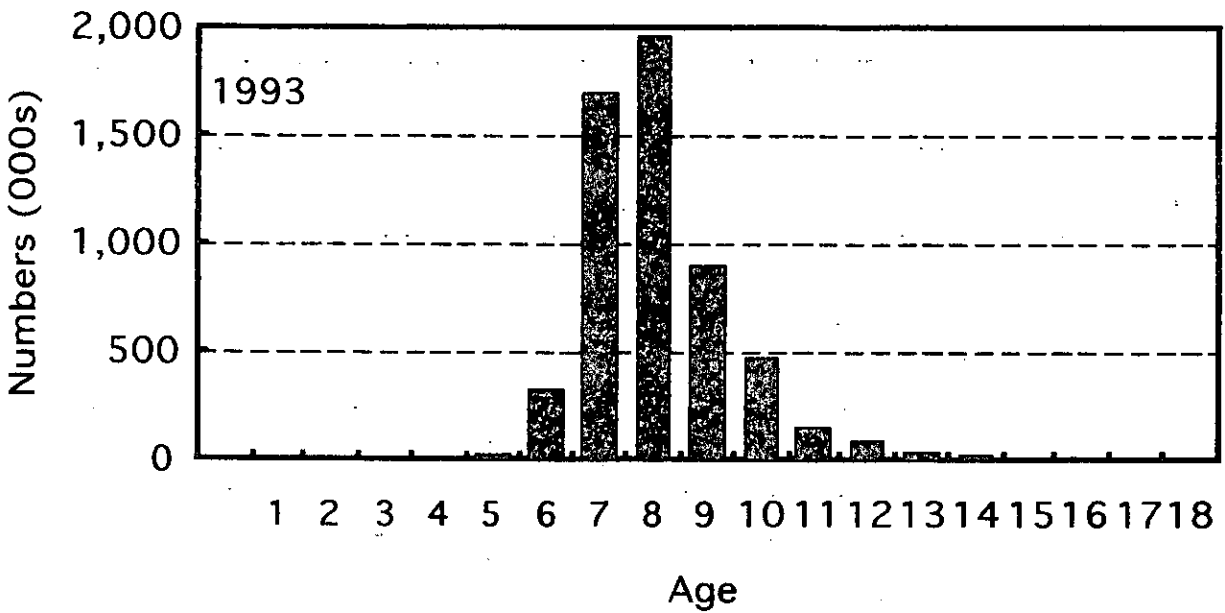
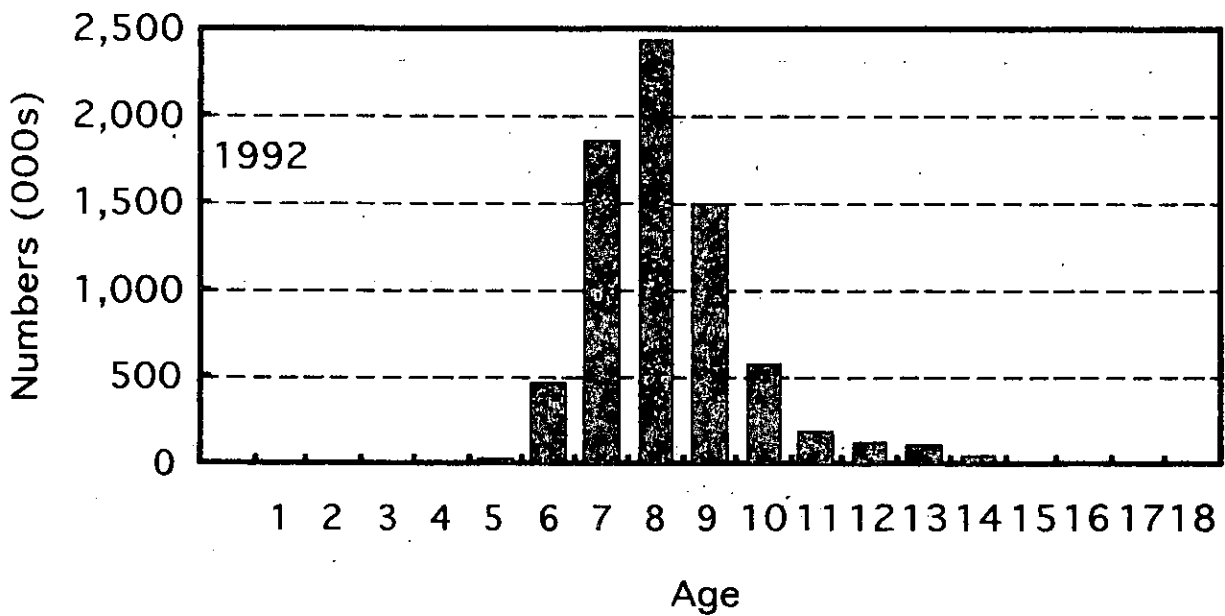


FIGURE 4: CONTINUED.