



## SCIENTIFIC COUNCIL MEETING – JUNE 2001

### Standardized Catch Rate Index for Greenland Halibut in SA2+3KLMNO

By

D. Power

Science Branch, Department of Fisheries and Oceans  
P. O. Box 5667, St. John's, Newfoundland, Canada A1C 5X1

### Abstract

Catch and effort data were analysed with a multiplicative model to derive a standardized catch rate index for Greenland halibut in NAFO SA2+3KLMNO. There were two measures of effort used (hours fished and days fished) in separate analyses because of the lack of hours fished data for EU-Portugal since 1992 and EU-Spain since 1995. The results indicate an increase in recent years from lowest the rates in the time series in 1997. It is uncertain whether the catch rate index is representative of stock abundance because fleets fish in different areas of the stock. The Canadian fleet operates within the 200-mile limit in Div. 3KL while foreign vessels fish in the NAFO Regulatory area outside the 200-mile limit primarily in Div. 3LMN.

### Introduction

A catch rate standardization based on commercial fishery data is presented for the assessment of Greenland halibut in SA2+3KLMNO.

### Materials and Methods

Catch and effort data from the directed fishery for G. halibut during the period 1975 to 1993 were obtained from ICNAF/NAFO Statistical Bulletins and were combined with provisional 1994-1999 NAFO Statlant 21B data and 1999-2000 Canadian data. The catch/effort data were analysed with a multiplicative model (Gavaris, 1980) to derive a standardized catch rate index for hours fished, as has been done in the last few assessments of this stock. A second standardization was conducted for days fished due to missing hours fished data from EU-Portugal since 1992 and EU-Spain since 1995.

Factors included in each model were a combination country-gear-tonnage-class category type (CGT), month, NAFO Division and year. Consistent with previous catch rate standardizations utilizing “hours fished”, individual observations of catch less than 10 tons or effort less than 10 hours fished were eliminated prior to analysis. Subsequently, any remaining categories where there were less than five occurrences in the database were also eliminated. For the days fished model the only difference in apriori elimination was that for the effort, data less than 5 days fished were eliminated.

### Results and Discussion

For the “hours fished” standardization, the regression was significant ( $p < 0.05$ ), explaining 58% of the variation in catch rates (Table 1). Although there was a significant year effect, there were only two years (1992 and 1997) that were significantly different from the 1975 reference year. The regression coefficients suggest that for the whole time period, catch rates were generally higher in winter and best in Subarea 2. The

standardized catch rate index (Table 2, Fig. 1 upper panel) shows high between and within year variability, especially in the late-1970s to mid-1980s. There was an increasing trend from the mid-1970s that peaked in 1982 and CPUE subsequently fluctuated but declined to the lowest rate observed in the 1997. Catch rate increased marginally in 1998, was at the same level in 1999 and increased again in 2000 (based solely on Canadian data).

For the “days fished” standardization, the regression was also significant ( $p < 0.05$ ), explaining 54% of the variation in catch rates (Table 3). The standardized catch rate index (Table 4, Fig. 1 lower panel) also shows high between and within year variability prior to the 1990’s. The catch rate was relatively stable to 1984 and, with the exception of an anomalous increase in 1987, declined by about 50% by 1988. Between 1988 and 1995 the index shows two cycles of increase followed by a decrease. Since 1995 the index declined gradually to the lowest rate observed in 1998, but has increased by 50% between 1998 and 2000. Similar to the “hours fished” index, over the whole time period, catch rates were generally higher in winter and higher in Subarea 2, based on the coefficients in Table 3.

It is uncertain whether the catch rate index is representative of stock abundance because fleets fish in different areas of the stock. The Canadian fleet operates within the 200-mile limit in Div. 3KL while foreign vessels fish in the NAFO Regulatory area outside the 200-mile limit primarily in Div. 3LMN.

Table 1. ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Greenland halibut in NAFO SA2 + Div. 3KLMNO. Effort is HOURS fished. (2000 based on preliminary data).

REGRESSION OF MULTIPLICATIVE MODEL				VAR REG. STD. NO.			
MULTIPLE R..... 0.763				CATEGORY CODE	#	COEF	ERR OBS
MULTIPLE R SQUARED..... 0.582				-----	---	---	---
ANALYSIS OF VARIANCE				11	31	-0.036	0.065 90
-----				12	32	0.082	0.071 72
SOURCE OF VARIATION				3	21	0.037	0.083 52
SUMS OF SQUARES	DF	MEAN SQUARE	F-VALUE	23	34	0.012	0.064 113
-----				31	35	-0.256	0.077 112
INTERCEPT	1	7.60E2	7.60E2	32	36	-0.196	0.085 219
REGRESSION	64	1.90E2	2.97E0	33	37	-0.474	0.101 89
Cntry Gear TC	21	3.91E1	1.86E0	34	38	-0.234	0.106 70
Month	11	1.32E1	1.20E0	35	39	-0.259	0.140 21
Division	7	8.09E0	1.16E0	4	76	-0.061	0.224 11
Year	25	2.52E1	1.01E0	77	41	0.088	0.216 19
RESIDUALS	738	1.36E2	1.85E-1	78	42	0.298	0.233 18
TOTAL	803	1.09E3		79	43	0.125	0.229 10
REGRESSION COEFFICIENTS				80	44	0.329	0.237 12
-----				81	45	0.146	0.225 15
VAR	REG.	STD.	NO.	82	46	0.404	0.219 19
CATEGORY CODE	#	COEF	ERR OBS	83	47	0.361	0.212 24
-----				84	48	0.294	0.214 23
Cntry Gear TC	3125	INT	-0.795	85	49	0.094	0.215 21
Month	9		0.213	86	50	-0.181	0.214 24
Division	22			87	51	0.109	0.206 33
Year	75			88	52	-0.259	0.215 22
1	3123	1	-0.204	89	53	-0.087	0.219 22
	3126	2	-0.125	90	54	-0.032	0.218 26
	9125	3	0.785	91	55	-0.321	0.213 51
	10127	4	1.064	92	56	-0.468	0.211 102
	11125	5	0.221	93	57	-0.257	0.214 84
	11126	6	-0.128	94	58	-0.416	0.216 101
	11127	7	0.370	95	59	-0.266	0.229 21
	14124	8	0.449	96	60	-0.433	0.223 23
	14126	9	0.726	97	61	-0.551	0.223 24
	14127	10	0.401	98	62	-0.367	0.230 34
	15126	11	0.298	99	63	-0.397	0.227 49
	16127	12	0.251	100	64	-0.069	0.246 9
	19124	13	-0.305				
	19125	14	-0.021				
	19126	15	0.302				
	20125	16	0.339				
	20126	17	-0.095				
	20127	18	-0.006				
	27125	19	0.211				
	34125	20	0.517				
	34126	21	0.265				
2	1	22	0.291				
	2	23	0.216				
	3	24	0.040				
	4	25	0.030				
	5	26	0.210				
	6	27	0.148				
	7	28	0.031				
	8	29	0.087				
	10	30	-0.281				

LEGEND FOR ANOVA RESULTS:

CGT CODES:

3123 = Can(NFLD) TC 3 | 15126 = Norway TC 6  
 3125 = Can(NFLD) TC 5 | 16127 = Poland TC 7  
 3126 = " TC 6 | 19124 = Spain TC 4  
 9125 = Fra(SPM) TC 5 | 19125 = " TC 5  
 10127 = Former FRG TC 7 | 19126 = " TC 6  
 11125 = Former DDR TC 5 | 20125 = Former USSR TC 5  
 11126 = " TC 6 | 20126 = " TC 6  
 11127 = " TC 7 | 20127 = " TC 7  
 14124 = Japan TC 4 | 27125 = Can(M) TC 5  
 14126 = " TC 6 | 34125 = Russia TC 5  
 14127 = " TC 7 | 34126 = " TC 6  
 All of the above CGT are Stern Trawlers

DIVISION CODES:

21 = 2G, 22 = 2H, 23 = 2J, 31 = 3K, 32 = 3L  
 33 = 3M, 34 = 3N, 35 = 3O

Table 2. Standardized catch rate index for Greenland halibut in NAFO SA2+ Div. 3KLMNO from a multiplicative model utilizing HOURS FISHED as a measure of effort. (2000 based on preliminary data).

PREDICTED CATCH RATE						
YEAR	LN TRANSFORM		RETRANSFORMED		CATCH	EFFORT
	MEAN	S.E.	MEAN	S.E.		
1975	-0.7948	0.0455	0.484	0.102	28814	59493
1976	-0.8554	0.0241	0.461	0.071	24611	53416
1977	-0.7066	0.0190	0.536	0.074	32048	59784
1978	-0.4972	0.0216	0.660	0.097	39070	59192
1979	-0.6693	0.0295	0.553	0.094	34104	61616
1980	-0.4659	0.0220	0.681	0.100	32867	48269
1981	-0.6490	0.0192	0.568	0.078	30754	54164
1982	-0.3905	0.0151	0.737	0.090	26278	35664
1983	-0.4336	0.0132	0.706	0.081	27861	39442
1984	-0.5011	0.0124	0.661	0.073	26711	40438
1985	-0.7008	0.0146	0.540	0.065	20347	37654
1986	-0.9762	0.0133	0.411	0.047	17976	43788
1987	-0.6857	0.0135	0.549	0.063	32442	59105
1988	-1.0540	0.0146	0.380	0.046	19215	50622
1989	-0.8819	0.0138	0.451	0.053	20034	44418
1990	-0.8263	0.0115	0.477	0.051	47454	99411
1991	-1.1161	0.0109	0.357	0.037	65008	181909
1992	-1.2624	0.0104	0.309	0.031	63193	204631
1993	-1.0515	0.0116	0.381	0.041	62455	163886
1994	-1.2106	0.0125	0.325	0.036	51029	157068
1995	-1.0605	0.0196	0.376	0.052	15272	40598
1996	-1.2282	0.0160	0.319	0.040	18840	59122
1997	-1.3457	0.0162	0.283	0.036	19858	70091
1998	-1.1617	0.0201	0.340	0.048	19946	58688
1999	-1.1917	0.0186	0.330	0.045	27000	81798
2000	-0.8637	0.0267	0.456	0.074	32969	72244

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.131

Table 3. ANOVA results and regression coefficients from a multiplicative model utilized to derive a standardized catch rate series for Greenland halibut in NAFO SA2 + Div. 3KLMNO. Effort is DAYS fished. (2000 based on preliminary data).

REGRESSION OF MULTIPLICATIVE MODEL				VAR. REG. STD. NO.						
MULTIPLE R..... 0.736				CATEGORY CODE # COEF ERR OBS						
MULTIPLE R SQUARED..... 0.542				-----						
ANALYSIS OF VARIANCE				12	32	0.041	0.073	81		
-----				3	21	0.132	0.100	43		
SOURCE OF VARIATION				23	34	0.064	0.076	103		
SUMS OF SQUARES				31	35	-0.281	0.092	100		
MEAN SQUARE				32	36	-0.243	0.099	267		
F-VALUE				33	37	-0.698	0.112	100		
-----				34	38	-0.397	0.113	111		
INTERCEPT	1	2.05E3	2.05E3	35	39	-0.376	0.149	23		
REGRESSION	64	2.01E2	3.14E0	14.673	4	76	40	-0.141	0.249	9
Cntry Gear TC	21	5.39E1	2.57E0	11.975	77	41	-0.073	0.238	15	
Month	11	1.79E1	1.63E0	7.592	78	42	-0.056	0.272	9	
Division	7	1.97E1	2.81E0	13.124	79	43	-0.010	0.260	8	
Year	25	2.10E1	8.38E-1	3.913	80	44	0.100	0.277	8	
RESIDUALS	793	1.70E2	2.14E-1		81	45	-0.271	0.253	12	
TOTAL	858	2.42E3			82	46	0.105	0.239	18	
REGRESSION COEFFICIENTS	-----			83	47	-0.025	0.228	25		
VAR. REG. STD. NO.	-----			84	48	0.070	0.235	21		
CATEGORY CODE # COEF ERR OBS	-----			85	49	-0.147	0.241	17		
Cntry Gear TC	3125	INT	2.054	0.237	858	86	50	-0.349	0.241	16
Month	9				87	51	-0.089	0.229	27	
Division	22				88	52	-0.534	0.235	21	
Year	75				89	53	-0.341	0.243	19	
1	3123	1	-0.513	0.160	10	90	54	-0.329	0.239	24
	3126	2	-0.107	0.179	8	91	55	-0.468	0.234	45
	9125	3	0.517	0.121	28	92	56	-0.580	0.231	99
	11125	4	-0.079	0.139	18	93	57	-0.357	0.233	86
	11126	5	-0.282	0.242	5	94	58	-0.349	0.233	109
	11127	6	0.159	0.141	16	95	59	-0.581	0.242	33
	14124	7	0.462	0.088	102	96	60	-0.602	0.236	42
	14126	8	0.551	0.140	19	97	61	-0.672	0.237	41
	14127	9	0.397	0.112	34	98	62	-0.695	0.234	98
	15126	10	0.289	0.235	5	99	63	-0.499	0.246	42
	16127	11	0.164	0.105	46	100	64	-0.289	0.274	8
	17126	12	-0.287	0.103	77					
	19124	13	-0.268	0.101	101					
	19125	14	-0.151	0.102	111					
	19126	15	0.423	0.131	28					
	20125	16	0.331	0.217	6					
	20126	17	-0.365	0.168	10					
	20127	18	-0.248	0.109	35					
	27125	19	0.133	0.134	16					
	34125	20	0.525	0.159	15					
	34126	21	0.328	0.161	19					
2	1	22	0.335	0.090	41					
	2	23	0.299	0.088	44					
	3	24	0.073	0.078	64					
	4	25	0.132	0.078	64					
	5	26	0.319	0.079	60					
	6	27	0.197	0.076	66					
	7	28	0.147	0.075	69					
	8	29	0.164	0.067	94					
	10	30	-0.237	0.071	82					
	11	31	-0.069	0.070	91					

LEGEND FOR ANOVA RESULTS:

CGT CODES:

3123 = Can(NFLD) TC 3 | 16127 = Poland TC 7  
 3125 = Can(NFLD) TC 5 | 17126 = Portugal TC 6  
 3126 = " TC 6 | 19124 = Spain TC 4  
 9125 = Fra (SPM) TC 5 | 19125 = " TC 5  
 11125 = Former DDR TC 5 | 19126 = " TC 6  
 11126 = " TC 6 | 20125 = Former USSR TC 5  
 11127 = " TC 7 | 20126 = " TC 6  
 14124 = Japan TC 4 | 20127 = " TC 7  
 14126 = " TC 6 | 27125 = Can(M) TC 5  
 14127 = " TC 7 | 34125 = Russia TC 5  
 15126 = Norway TC 6 | 34126 = " TC 6

All of the above CGT are Stern Trawlers

DIVISION CODES:

21 = 2G, 22 = 2H, 23 = 2J, 31 = 3K, 32 = 3L  
 33 = 3M, 34 = 3N, 35 = 3O

Table 4. Standardized catch rate index for Greenland halibut in NAFO SA2+ Div. 3KLMNO from a multiplicative model utilizing DAYS FISHED as a measure of effort. (2000 based on preliminary data).

PREDICTED CATCH RATE							
YEAR	LN TRANSFORM		RETRANSFORMED		CATCH	EFFORT	
	MEAN	S.E.	MEAN	S.E.			
1975	2.0544	0.0564	8.444	1.978	28814	3412	
1976	1.9129	0.0346	7.410	1.368	24611	3321	
1977	1.9810	0.0264	7.965	1.287	32048	4024	
1978	1.9982	0.0355	8.066	1.508	39070	4843	
1979	2.0445	0.0406	8.427	1.682	34104	4047	
1980	2.1545	0.0358	9.429	1.770	32867	3486	
1981	1.7837	0.0291	6.530	1.107	30754	4710	
1982	2.1594	0.0192	9.555	1.319	26278	2750	
1983	2.0299	0.0163	8.407	1.068	27861	3314	
1984	2.1245	0.0166	9.239	1.187	26711	2891	
1985	1.9075	0.0206	7.422	1.061	20347	2741	
1986	1.7059	0.0214	6.064	0.883	17976	2964	
1987	1.9649	0.0202	7.862	1.113	32442	4126	
1988	1.5204	0.0192	5.043	0.696	19215	3810	
1989	1.7138	0.0182	6.123	0.824	20034	3272	
1990	1.7251	0.0148	6.203	0.752	47454	7650	
1991	1.5860	0.0137	5.400	0.630	65008	12038	
1992	1.4746	0.0139	4.830	0.568	63193	13082	
1993	1.6978	0.0145	6.037	0.724	62455	10346	
1994	1.7057	0.0149	6.083	0.741	51029	8389	
1995	1.4736	0.0198	4.812	0.674	15272	3174	
1996	1.4527	0.0170	4.719	0.613	18840	3993	
1997	1.3824	0.0171	4.398	0.573	19858	4515	
1998	1.3597	0.0156	4.302	0.536	19946	4636	
1999	1.5556	0.0222	5.216	0.773	27000	5176	
2000	1.7650	0.0350	6.390	1.186	32969	5159	

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.149

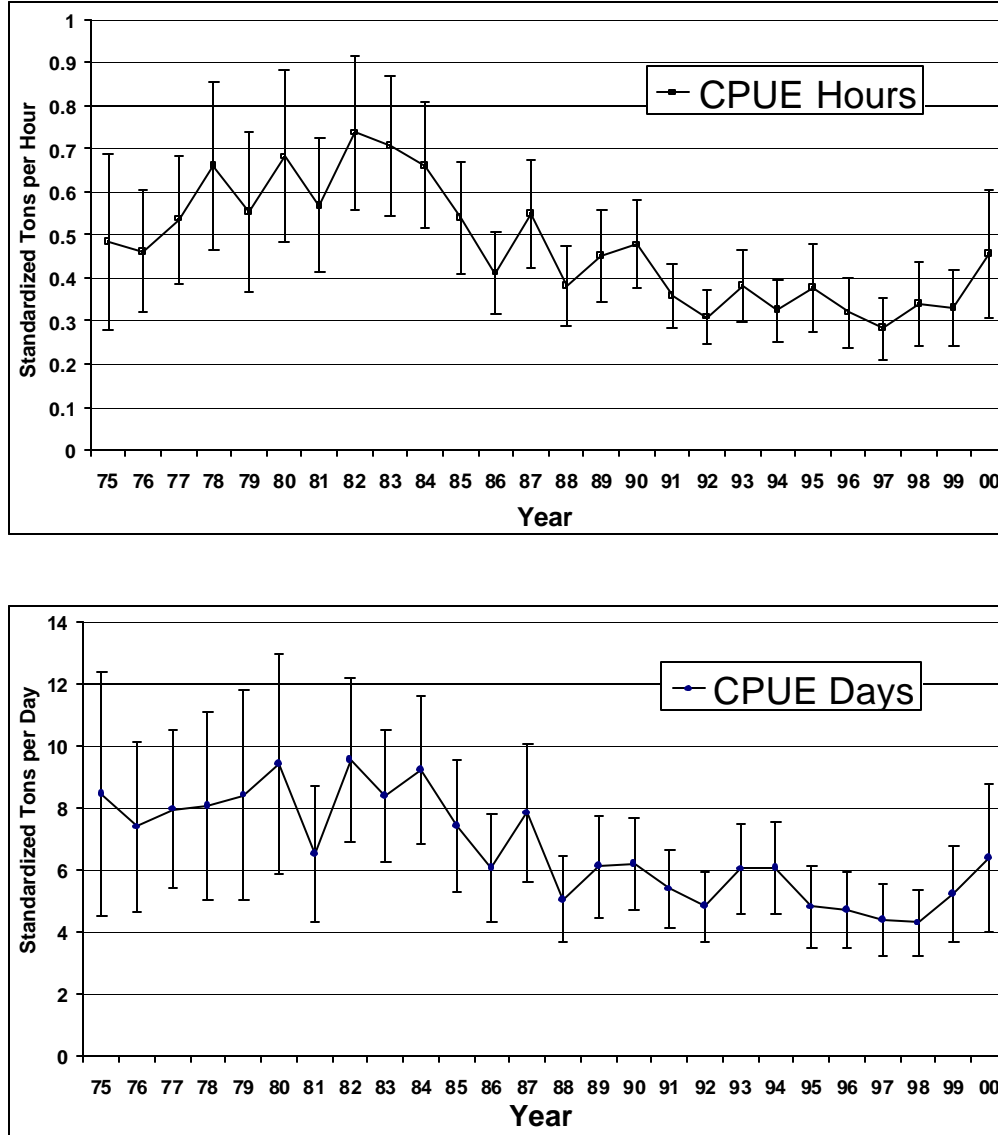


Fig. 1. Standardized CPUE  $\pm$  2 standard errors for Greenland Halibut in SA2 + Div. 3KLMNO from 1975-2000 (preliminary) utilizing effort in HOURS fished (upper panel) and DAYS fished.