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

by

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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 were used (hours fished and days fished) in separate analyses because of the lack of hours fished data for some fleets. The results indicate an increase in recent years from lowest the rate in the time series in 1997, which is consistent with improved recruitment. 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 non-Canadian 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 Greenland halibut during the period 1975 to 1999 were obtained from ICNAF/NAFO Statistical Bulletins and were combined with provisional 2000 NAFO STATLANT 21B data and 2001 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 two major fleets, 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 in catch rate from the mid-1970s that peaked in 1982. CPUE subsequently fluctuated but declined by 60% to the lowest rate estimated in 1997. Catch rate has increased steadily from 1997 to 2001. The increase is consistent with improved recruitment of several successive year classes from 1993-1995 (Bowering, 2001; Mahe and Bowering, 2001). The 2001 estimate, based solely on preliminary Canadian data is about 65% of the highest rate in the series in 1982.

For the "days fished" standardization, the regression was also significant ($p < 0.05$), explaining 55% 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 anamalous increase in 1987, declined by about 45% 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 2001. The 2001 estimate, based solely on preliminary Canadian data, is about 70% of the highest estimate in the series in 1982. 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 non-Canadian vessels fish in the NAFO Regulatory area outside the 200-mile limit primarily in Div. 3LMN.

References

Bowering, W.R. 2001. Population Trends in the Greenland halibut *(Reinhardtius hippoglossoides)* Resource of NAFO Subarea 2 and Divisions 3KLMNO based on Canadian Research Vessel Survey Results during 1978-2000. NAFO SCR Doc. 01/39, Ser. No. N4417, 42p.

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.

Mahe, J-C and Bowering, W.R. 2001. An Assessment of Stock Status of the Greenland Halibut Resource in NAFO Subarea 2 and Divisions 3KLMNO based on Extended Survivors Analysis. NAFO SCR Doc. 01/80, Ser. No. N4459, 18p.

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. (2001 based on preliminary data).

REGRESSION OF MULTIPLICATIVE MODEL
MULTIPLE R..... 0.762
MULTIPLE R SQUARED..... 0.581

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARE	F-VALUE
INTERCEPT	1	7.74E2	7.74E2	
REGRESSION	65	1.91E2	2.94E0	16.280
Cntry|Gear|TC(1)	21	4.00E1	1.91E0	10.544
Month(2)	11	1.24E1	1.13E0	6.262
Division(3)	7	7.74E0	1.11E0	6.122
Year(4)	26	2.58E1	9.91E-1	5.482
RESIDUALS	764	1.38E2	1.81E-1	
TOTAL	830	1.10E3		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
Cntry|Gear|TC	3125	INT	-0.802	0.211	830
Division	9				
Month	22				
Year	75				
1	3123	1	-0.199	0.153	9
	3126	2	-0.126	0.164	8
	9125	3	0.775	0.158	12
	10127	4	1.074	0.183	8
	11125	5	0.235	0.131	16
	11126	6	-0.112	0.201	6
	11127	7	0.383	0.123	17
	14124	8	0.445	0.073	114
	14126	9	0.733	0.112	23
	14127	10	0.409	0.093	43
	15126	11	0.300	0.198	6
	16127	12	0.264	0.088	51
	19124	13	-0.309	0.092	102
	19125	14	-0.025	0.101	75
	19126	15	0.297	0.117	28
	20125	16	0.337	0.185	7
	20126	17	-0.086	0.142	12
	20127	18	0.003	0.095	37
	27125	19	0.244	0.098	26
	34125	20	0.516	0.155	17
	34126	21	0.261	0.144	22
2	1	22	0.254	0.084	40
	2	23	0.202	0.082	44
	3	24	0.056	0.076	57
	4	25	0.049	0.075	60
	5	26	0.210	0.077	54
	6	27	0.148	0.072	65
	7	28	0.032	0.068	74
	8	29	0.088	0.063	89
	10	30	-0.274	0.065	83
	11	31	-0.047	0.064	91
	12	32	0.073	0.070	73
3	21	33	0.045	0.082	52
	23	34	0.004	0.063	117
	31	35	-0.240	0.075	118
	32	36	-0.176	0.082	236
	33	37	-0.455	0.099	89
	34	38	-0.218	0.103	70
	35	39	-0.243	0.137	21
4	76	40	-0.061	0.222	11
	77	41	0.074	0.213	19
	78	42	0.288	0.230	18
	79	43	0.109	0.226	10
	80	44	0.315	0.234	12
	81	45	0.132	0.222	15
	82	46	0.395	0.216	19
	83	47	0.357	0.209	24
	84	48	0.295	0.212	23
	85	49	0.091	0.213	21
	86	50	-0.173	0.212	24
	87	51	0.113	0.203	33
	88	52	-0.260	0.212	22
	89	53	-0.084	0.216	22
	90	54	-0.030	0.215	26
	91	55	-0.318	0.210	51
	92	56	-0.472	0.208	102
	93	57	-0.264	0.211	84
	94	58	-0.422	0.212	101
	95	59	-0.276	0.226	21
	96	60	-0.439	0.219	23
	97	61	-0.558	0.220	24
	98	62	-0.377	0.227	34
	99	63	-0.404	0.224	49
	100	64	-0.129	0.222	19
	101	65	-0.025	0.223	17

LEGEND FOR AVOVA RESULTS:

CGT CODES: All are Stern Trawlers

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

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. (2001 based on preliminary data).

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1975	-0.8016	0.0444	0.480	0.100	28814	59995
1976	-0.8626	0.0235	0.457	0.070	24611	53896
1977	-0.7272	0.0184	0.524	0.071	32048	61138
1978	-0.5137	0.0210	0.648	0.093	39070	60284
1979	-0.6923	0.0285	0.540	0.091	34104	63154
1980	-0.4865	0.0212	0.666	0.097	32867	49359
1981	-0.6701	0.0186	0.555	0.075	30754	55421
1982	-0.4068	0.0145	0.724	0.087	26278	36319
1983	-0.4442	0.0127	0.698	0.078	27861	39939
1984	-0.5067	0.0120	0.656	0.072	26711	40745
1985	-0.7109	0.0141	0.534	0.063	20347	38110
1986	-0.9745	0.0129	0.410	0.047	17976	43797
1987	-0.6884	0.0131	0.546	0.062	32442	59380
1988	-1.0621	0.0142	0.376	0.045	19215	51135
1989	-0.8855	0.0133	0.449	0.052	20034	44661
1990	-0.8317	0.0112	0.474	0.050	47454	100142
1991	-1.1199	0.0106	0.355	0.036	65008	182944
1992	-1.2737	0.0099	0.305	0.030	63193	207347
1993	-1.0654	0.0111	0.375	0.039	62455	166489
1994	-1.2239	0.0119	0.320	0.035	51029	159460
1995	-1.0779	0.0185	0.369	0.050	15272	41377
1996	-1.2402	0.0153	0.314	0.039	18840	59939
1997	-1.3600	0.0154	0.279	0.034	19858	71222
1998	-1.1783	0.0191	0.334	0.046	19946	59762
1999	-1.2058	0.0177	0.325	0.043	24226	74564
2000	-0.9302	0.0167	0.428	0.055	34177	79806
2001	-0.8268	0.0169	0.475	0.061	29437	61994

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.128

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. (2001 based on preliminary data).

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.741

MULTIPLE R SQUARED..... 0.549

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARE	F-VALUE
INTERCEPT	1	2.24E3	2.24E3	
REGRESSION	67	2.24E2	3.34E0	15.766
Cntry|Gear|TC(1)	23	6.26E1	2.72E0	12.832
Month(2)	11	1.95E1	1.78E0	8.374
Division(3)	7	2.27E1	3.24E0	15.283
Year(4)	26	2.34E1	9.00E-1	4.242
RESIDUALS	868	1.84E2	2.12E-1	
TOTAL	936	2.65E3		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VAR #	REG. COEF	STD. ERR	NO. OBS
Cntry|Gear|TC	3125	INT	2.030	0.236	936
Division	9				
Month	22				
Year	75				
1	3123	1	-0.501	0.158	10
	3126	2	-0.098	0.177	8
	9125	3	0.535	0.117	28
	11125	4	-0.064	0.138	18
	11126	5	-0.260	0.241	5
	11127	6	0.179	0.140	16
	14124	7	0.478	0.083	109
	14126	8	0.570	0.139	19
	14127	9	0.419	0.106	37
	15126	10	0.302	0.233	5
	16127	11	0.178	0.103	46
	17126	12	-0.270	0.092	112
	19124	13	-0.216	0.097	101
	19125	14	-0.101	0.098	111
	19126	15	0.463	0.128	28
	19166	16	0.388	0.184	8
	20125	17	0.346	0.215	6
	20126	18	-0.345	0.167	10
	20127	19	-0.242	0.108	35
	27125	20	0.166	0.129	17
	34125	21	0.554	0.155	15
	34126	22	0.421	0.132	24
	34127	23	-0.082	0.226	5
2	1	24	0.314	0.084	49
	2	25	0.299	0.081	57
	3	26	0.137	0.074	77
	4	27	0.185	0.075	73
	5	28	0.338	0.075	68
	6	29	0.206	0.073	73
	7	30	0.146	0.073	72
	8	31	0.187	0.066	95
	10	32	-0.226	0.069	85
	11	33	-0.078	0.068	96
	12	34	0.078	0.071	86
3	21	35	0.140	0.099	43
	23	36	0.056	0.075	107
	31	37	-0.262	0.091	104
	32	38	-0.236	0.096	316
	33	39	-0.718	0.109	102
	34	40	-0.477	0.108	130
	35	41	-0.409	0.146	23
4	76	42	-0.137	0.248	9
	77	43	-0.095	0.237	15
	78	44	-0.068	0.270	9
	79	45	-0.036	0.258	8
	80	46	0.072	0.275	8
	81	47	-0.294	0.251	12
	82	48	0.097	0.238	18
	83	49	-0.025	0.227	25
	84	50	0.072	0.233	21
	85	51	-0.146	0.239	17
	86	52	-0.348	0.240	16
	87	53	-0.090	0.228	27
	88	54	-0.537	0.233	21
	89	55	-0.338	0.241	19
	90	56	-0.326	0.238	24
	91	57	-0.465	0.232	45
	92	58	-0.590	0.229	99
	93	59	-0.377	0.230	88
	94	60	-0.364	0.230	112
	95	61	-0.575	0.239	33
	96	62	-0.595	0.234	42
	97	63	-0.681	0.234	41
	98	64	-0.701	0.231	98
	99	65	-0.539	0.235	60
	100	66	-0.242	0.234	48
	101	67	-0.288	0.248	15

LEGEND FOR AVOVA RESULTS:

CGT CODES: All are Stern Trawlers

3123 = Can(NFLD)	TC 3	17126 = Portugal	TC 6		
3125 = Can(NFLD)	TC 5	19124 = Spain	TC 4		
3126 = "	TC 6	19125 = "	TC 5		
9125 = Fra (SPM)	TC 5	19126 = "	TC 6		
11125 = Former DDR	TC 5	19166 =SpainPairTrawl	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		
16127 = Poland	TC 7	34127 = "	TC 7		

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. (2001 based on preliminary data).

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
1975	2.0305	0.0556	8.239	1.917	28814	3497
1976	1.8930	0.0342	7.258	1.331	24611	3391
1977	1.9355	0.0259	7.604	1.216	32048	4215
1978	1.9630	0.0349	7.781	1.443	39070	5021
1979	1.9941	0.0398	8.007	1.583	34104	4259
1980	2.1025	0.0351	8.945	1.661	32867	3674
1981	1.7362	0.0285	6.222	1.043	30754	4943
1982	2.1277	0.0188	9.248	1.264	26278	2841
1983	2.0052	0.0159	8.194	1.030	27861	3400
1984	2.1026	0.0163	9.030	1.149	26711	2958
1985	1.8842	0.0202	7.244	1.025	20347	2809
1986	1.6822	0.0210	5.917	0.854	17976	3038
1987	1.9408	0.0199	7.668	1.076	32442	4231
1988	1.4935	0.0189	4.905	0.671	19215	3918
1989	1.6921	0.0178	5.986	0.796	20034	3347
1990	1.7040	0.0145	6.067	0.728	47454	7821
1991	1.5650	0.0134	5.283	0.610	65008	12305
1992	1.4402	0.0133	4.663	0.537	63193	13551
1993	1.6538	0.0137	5.772	0.674	62455	10820
1994	1.6670	0.0140	5.848	0.690	51029	8726
1995	1.4556	0.0187	4.723	0.643	15272	3234
1996	1.4351	0.0160	4.633	0.585	18840	4066
1997	1.3500	0.0163	4.255	0.541	19858	4667
1998	1.3296	0.0147	4.172	0.504	19946	4781
1999	1.4919	0.0168	4.902	0.634	24226	4942
2000	1.7889	0.0161	6.600	0.834	34177	5178
2001	1.7427	0.0222	6.282	0.931	29437	4686

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.144

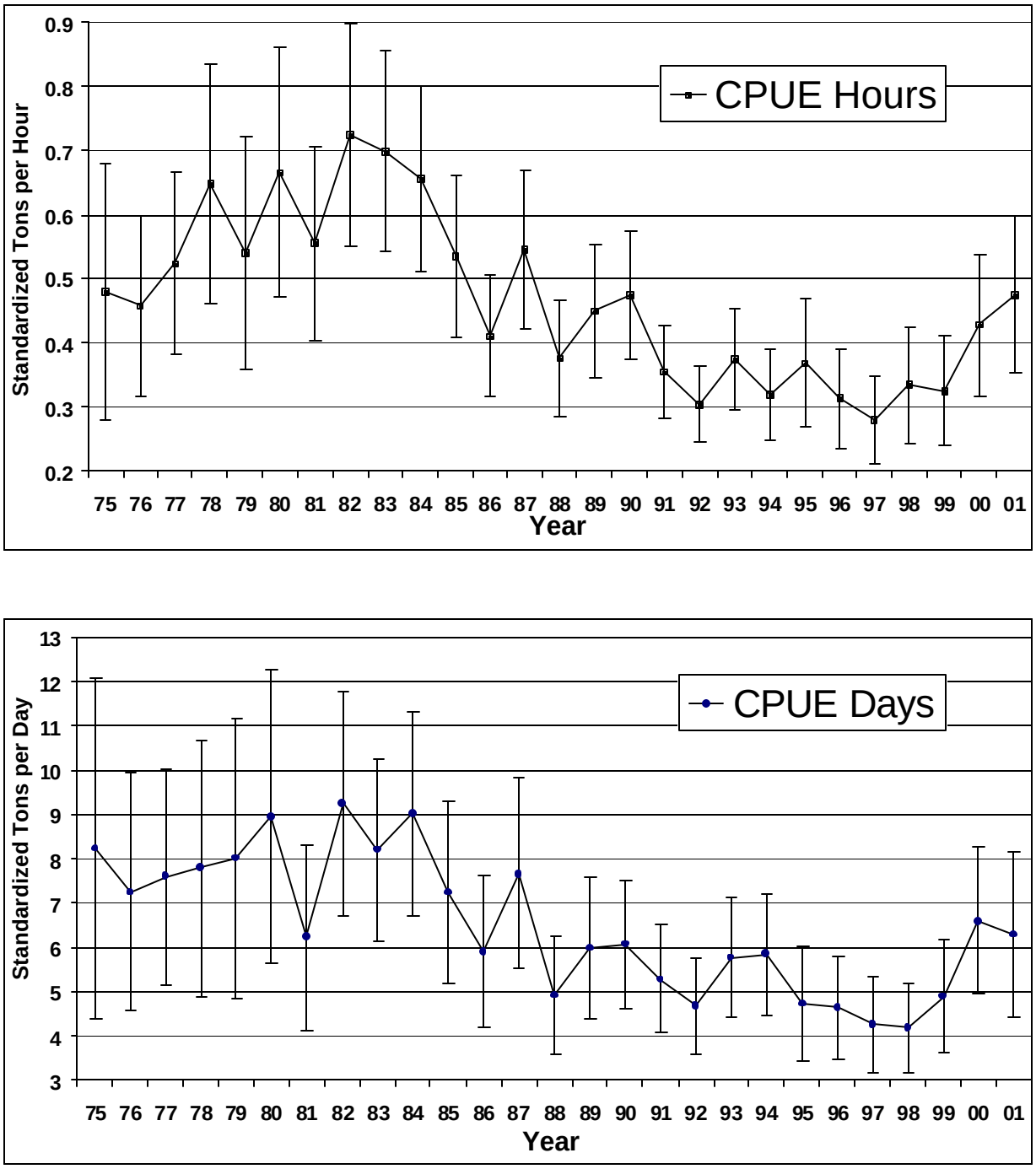

Fig. 1. Standardized CPUE ± 2 standard errors for Greenland Halibut in SA2 + Div. 3KLMNO from 1975-2000 (preliminary) utilizing effort in HOURS fished (upper panel) and DAYS fished.