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A method to estimate the NAFO Subarea 2+3KLMNO GHL catches based on survey information

by

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Abstract

In the period 2011-2015 the SC has not approved the NAFO Subarea 2+3KLMNO GHL catches due to inconsistencies in the available information to estimate it. The method propose in this paper is based on the linear regression relationship between the Scientific Observers and Surveys CPUEs. The method has some caveats. Nevertheless, the method could be used to know the level of discrepancies between the STATLANT and the estimation made based on the Scientific Observers CPUEs in some cases. Results show that the discrepancies between the estimations made base on the scientific observers CPUEs and the STATLANT figures present a decreased trend in time, being around the 50% more in the last two years. This seems to be an important improvement in the quality of the STATLANT figures in the last years compare with the years before. It is proposed to use the method explain in this paper to estimate catches in the 2011-2014 period where the discrepancies where bigger and used the official NAFO information (STATLANT, DCR, haul by haul data) for 2015 where the discrepancies seems to be smaller.

Introduction

The NAFO Joint Fisheries Commission-Scientific Council Working Group on Risk-Based Management Strategies (FC-SC WG-RBMS) in 5-7 February 2014 meeting (NAFO FC/SC Doc. 14/02) in its agenda item 8 proposed a work plan to review the Greenland Halibut Management Strategy Evaluation in 2017. This work plan was endorsed by the SC and FC in 2014. In 2016, the FC-SC WG-RBMS review this work plan and proposed a new one (NAFO, 2016).

The new work plan establish that during its 2016 June meeting Scientific Council should update two assessment models, one XSA based and one SCAA based, and evaluate the development of the stock since the introduction of the MSE.

To carry out these assessments it will be necessary to update the catches till 2015. In the period 2011-2015 the SC has not approved the NAFO Subarea 2+3KLMNO GHL catches due to inconsistencies in the available information to estimate those (NAFO SCS 15/12). Previous 2011, the base information to calculate for some countries the SC GHL catches was the Scientific Observers information. After 2011 this information it is not available and the catch information available are the STATLANT 21 and the Daily Catch Reports (DCR). For GHL the differences between the SC estimated catches and the STATLANT 21 in the period 2000-2010 were significant (Table 1).

The objective of this document is to present a possible method to estimate GHL catches in the period 2011-2015, based on the survey information, that are consistent with those estimated by the SC before 2011.

Data

NAFO Vessels monitoring System (VMS): NAFO Secretariat estimated the effort made in the NAFO Regulatory Area (NRA) by depth strata based on the VMS data (Campbell and Federizon, 2013). Table 2 shows the NRA VMS effort (Fishing Hours) for the strata more than 750 meters for the period 2008-2015 for the most important countries fishing Greenland halibut in the NAFO regulatory area (NRA) Divisions 3LMNO by year.

NAFO STATLANT 21A: Table 3 presents the 2008-2014 NAFO Divisions 3LMNO GHL STATLANT 21A catches (tons) extracted in January 2016 for the same countries with NRA VMS effort.

Commercial LPUE: It was estimated the "official" NAFO Divisions 3LMNO GHL LPUE (STATLANT catches/VMS effort) for the period 2008-2014 for these countries (Figure 1).

Survey CPUE: The NRA GHL fishing ground are quite well surveyed either spatially or in depth by the EU 3NO, 3L and Flemish cap surveys. Table 4 shows the estimated NRA GHL commercial LPUE as well as the EU 3NO (Gonzalez-Troncoso *et al*, 2015), 3L (Roman *et al*, 2015) and Flemish cap (Casas and Gonzalez-Troncoso, 2015) surveys mean weight per tow (MWPT) by division and year as well as the correlation coefficient (CC) between commercial LPUEs and surveys CPUEs by country and Division and for the period 2008-2014. This analysis has not been conducted for the Division 3O due to the very small portion of the catch and effort of the Greenland halibut fishery occurring in the NRA Division 3O.

Scientific Observer CPUE

The Scientific Observer CPUEs are those estimated based on the data collected on board by the scientific observers from the national sampling programs. These observers are different from NAFO control observers. Commercial LPUE (STATLANT/VMS) (2008-2015), Scientific Observer CPUE (2004-2010) and Survey CPUE (MWPT) (2004-2015) by year and Division are only available for one country and are presented in Table 5. Table 6 shows the NAFO observers effort (2004-2015) for this country at more than 700 m. This effort with the Scientific Observers CPUEs was used before 2011 to estimate the GHL catches (Gonzalez-Costas, 2013). Figure 2 shows this country VMS effort and the NAFO Observers effort by year at more than 700 meters depth (2008-2015).

Method

The method propose to be tested are based in the relationship between the Scientific Observers and Surveys CPUEs. It can be estimated the linear regression equation with the 2004-2010 data:

$$Scientific\ Observers\ CPUE = b * Surveys\ CPUE \quad (1)$$

where b is the slope of the linear regression.

In Table 4 can be observed that the Commercial LPUEs estimated through the STATLANT and the VMS data have a low CC to the Surveys CPUEs for almost the countries and Divisions. For the one country that we have available data, the CC of the Scientific Observers CPUE and the STATLAN/VMS LPUE versus the Surveys CPUES are quite different being the Scientific Observers CPUE versus the Surveys CPUES much higher than the STATLANT/VMS LPUE (Table 5). Based on this fact it was decided to apply the method to the Scientific Observers and Surveys CPUEs.

With equation 1 we can estimate a new commercial Observers CPUEs based on the Survey CPUE information through the linear regression equation being the Surveys CPUE the independent variable. Catches could be estimated multiplicand these new estimated Observers CPUEs by the VMS effort or the NAFO Scientific effort. This method was applied to the data of one country to estimate the GHL catches.

It was estimated the 2015 catches with the same method used to estimate the SC catches before 2011 (Gonzalez-Costas, 2013). This method used the Scientific Observers CPUEs and the NAFO Observers effort

data. It was also estimated the uncertainty of this estimation by bootstrap. By Division it was made a 250 bootstrap with the Scientific Observers observations to have 250 different CPUEs to estimate the catches. Additionally it was compute the catches based on the NAFO Observers haul by haul information. This catches are very similar to the STATLANT catches for this country. Based on this information we made 250 samples by division without replacement with equal level of the Scientific Observers observations to estimate the uncertainty of this catches with a sample level equal to the Scientific Observers in 2015.

Results

For the one country that we have available data, it was estimated the linear regression equation (1) . These regressions by Division are presented in Figure 3. It was assumed that the regression line pass through the origin. The results shows that the R square of these relations are not very high and a little bit noisy. After it was estimated by the linear regression equation what would be the new Scientific Observers CPUE by Division for the period 2006-2015 where we have survey information for Divisions 3LMN. In Division 3O due to the low Scientific Observers information and the small percentage of the effort and catches of the GHL NRA fishery it was decided apply the 3N estimated CPUE. Taking in account the knowledge of the Survey CPUE by Division it was estimated a new commercial Scientific Observers CPUE by Division (*eq. 1*). These new estimated CPUEs are presented in Table 7. The GHL catches can be estimated with these estimated CPUEs multiply by the VMS effort at more than 700 meters for the period 2008-2015. Table 8 present these estimated catches.

Table 9 present the GHL Catches estimated with the regression estimated CPUE multiply by the NAFO observer's effort at more than 700 meters by year and Division for the period 2006-2015. Table 10 shows the SC GHL estimated catches for this country in the period 2004-2010. This catches where estimated based on the "real" Scientific Observers CPUE and the NAFO Observers effort. Figure 4 present the one country GHL different estimated catches: through the new estimated CPUE with the VMS effort (2008-2015) and the NAFO Observers effort at more than 700 meters (2006-2015); the SC approved catches (2004-2010) as well as the GHL STATLANT catches (2004-2014).

Different catch estimations were made for 2015 to have an idea of the differences and uncertainties of the catches estimations. Figure 5 present for 2015 the NAFO observers catches and the Scientific Observers estimation and their uncertainties as well as the catch estimation applying the method explained in this paper.

Discussion

The method has some caveats. The Surveys CPUEs are designed to be a biomass index. Commercial CPUEs are not designed to be biomass indices and they are not always equivalent to the Surveys CPUEs or biomass indices. There are some problems when we want to use the Commercial CPUEs as biomass indices. These problems for the Greenland halibut were point it out by the Scientific Council due to different problems in surveys coverage and fishing concentration (SCxxx). Nevertheless it is expected that the correlation between them are high in most cases because they measure the same resource.

Other problem is that in the linear regression assumed that all the error is in the dependent variable, in this case the commercial Scientific Observers CPUE while assumed that the independent variable, in this case the survey CPUE, is measure without error and it is not the real case where we know that the surveys CPUEs are measure with a quite important error.

The linear regression between the commercial Scientific Observers and the Surveys CPUEs are quite noisy in this case (Figure 3). This noise may be due to the few existing data to establish the relationships as well as the problems commented above.

Nevertheless, the method could be used to know the level of discrepancies between the STATLANT and the estimation made based on the Scientific Observers CPUEs in some cases.

In Figure 2 it can be observed that the VMS effort at more than 700 meters is normally higher than the NAFO observers effort. These different could be due to the method used to estimated the effort based on the VMS information while the NAFO Observers effort normally is the real fishing effort and it was used before 2011 to estimated the SC GHL catches for the country used in this study.

In the period 2006-2010 where we have available catches approved by SC and catches estimations made with the new scientific observers CPUEs and the NAFO Observers effort we can observe that these estimations are quite similar for all the years except 2006 and are more than the double of the STATLANT numbers (Figure 4).

In the period 2011-2015, it can be observed in Figure 4 that the estimation made with the new Scientific Observed CPUEs and the VMS effort is a little bit higher than the estimation made with NAFO Observers effort. This is due to the differences between the VMS effort and the NAFO Observers effort. We can also observe that the discrepancies between these estimations present a decrease trend in time, being only around the 50% more in the last two years (see also table 1). This seems to be an important improvement in the quality of the STATLANT figures in recent years compare with the years before.

In 2015, this improvement could be higher as shown in Figure 5. The estimation made with the Scientific Observers CPUE are more close to the NAFO Observers catches, normally very similar to the STATLANT figures, than the estimation made with the new Observers CPUEs estimated with this method. These smaller discrepancies between the NAFO official data and the scientific observers estimation could be even less with the use of the DCR or the haul by haul data instead the NAFO Observers catches.

One way to obtain GHL catches consistent with the SC estimations till 2010 could be used the method propose in this paper to estimate catches in the 2011-2014 period where the discrepancies where bigger and used the official NAFO information (STATLANT, DCR, haul by haul data) for 2015 where the discrepancies seems to be smaller.

REFERENCES

Campbell, N. and Ricardo Federizon, 2013. ESTIMATING FISHING EFFORT IN THE NAFO REGULATORY AREA USING VESSEL MONITORING SYSTEM DATA. Serial No. N6144 NAFO SCR Doc. 13/001.

Casas J.M. and D. González Troncoso, 2015. Results from Bottom Trawl Survey on Flemish Cap of June-July 2014. SCR Doc. 15-017. Serial No. N6438.

González-Costas, F. 2013. Method to estimate catches based on the Observers on board information. Serial No. N6211 NAFO SCR Doc. 13/052.

González-Troncoso, D., E. Román, N. Vilas and A. Nogueira, 2015. Results for Greenland halibut, American plaice and Atlantic cod of the Spanish survey in NAFO Div. 3NO for the period 1997-2014. NAFO SCR Doc. 15/007. Serial No. N6427.

NAFO. 2014. Report of the Fisheries Commission and Scientific Council Joint Working Group on Risk-Based Management Strategies. 5-7 February 2014. Serial No. 6282 NAFO FC/SC Doc. 14/02.

NAFO. 2015. Report of the Scientific Council Meeting. 29 May-11 June 2015. Serial No. N6469 NAFO SCS Doc. 15-12 (pag 98-99).

NAFO. 2016. Report of the NAFO Joint Fisheries Commission–Scientific Council Working Group on Risk-Based Management Strategies. 4-6 April 2016 Tórshavn, Faroe Islands. Serial No. N6532 NAFO FC/SC Doc. 16/01.

Román, E., C. González-Iglesias and D. González-Troncoso, 2015. Results for the Spanish Survey in the NAFO Regulatory Area of Division 3L for the period 2003-2014. NAFO SCR Doc. 15/019. Serial No. N6440.

Table 1. Greenland halibut Subarea 2+3KLMNO STATLANT 21A and Scientific Council estimated catches (2000-2014) and the ratio SC catches/STATLANT 21A.

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
STATLANT 21A	32693	33602	30783	30648	17098	17786	17713	15349	15044	14669	15677	15812	15284	15386	15542
SC Catches	34177	38232	34062	35151	25486	23225	23531	22747	21178	23156	26174				
SC/21A	1.05	1.14	1.11	1.15	1.49	1.31	1.33	1.48	1.41	1.58	1.67				

Table 2. NRA VMS effort (hours) by year (2008-2015) at more than 750 meters depth for the more important countries participating in the NRA Greenland halibut fishery.

Sum of pingtime		YEAR								
Division	FMC_NATION_CODE	2008	2009	2010	2011	2012	2013	2014	2015	Total
3L	ESP	9085	10791	12758	11904	13288	7458	7141	6179	78603
	PRT	5760	7660	10770	10830	10994	7345	6491	4630	64478
	RUS	2433	3380	3743	4427	4625	9285	8455	3185	39533
	EST	2048	1798	2686	1528	669	1639	1558	1104	13030
	FRO	669	710	586	1179	728	739	453	135	5198
Total 3L		**19995**	**24338**	**30543**	**29868**	**30303**	**26465**	**24098**	**15232**	**200842**
3M	ESP	5179	4465	4153	5388	5372	2604	2357	3021	32540
	PRT	2899	3519	4365	5456	6105	2748	3782	2340	31215
	RUS	889	369	929	306	1272	1549	755	3398	9467
	EST	350	460	763	1316	164	1274	783	211	5320
	FRO	130	92	36	93	314	62	75	314	1117
Total 3M		**9447**	**8905**	**10247**	**12559**	**13228**	**8237**	**7753**	**9284**	**79660**
3N	ESP	807	1046	2005	2934	2785	1209	1472	908	13167
	PRT	296	527	469	1730	695	832	481	581	5612
	EST	100	10	12	21	594	293	322	400	1752
	RUS	306	286	283	168	277	202	98	112	1733
	FRO	38		16	4	6	7			71
Total 3N		**1547**	**1869**	**2785**	**4858**	**4358**	**2543**	**2373**	**2001**	**22334**
3O	PRT	319	190	111	103	163	214	236	536	1872
	ESP	102	135	228	177	267	53	11	236	1209
	RUS	5	10	2	16	12	20	58	31	155
	FRO	29				9	9			47
	EST					23	1	3	6	33
Total 3O		**455**	**335**	**341**	**296**	**474**	**298**	**308**	**809**	**3317**
Total		**31444**	**35448**	**43916**	**47582**	**48363**	**37543**	**34531**	**27327**	**306154**

Table 3. NAFO Subarea 2+3KLMNO GHL catches from the STATLANT 21A (2008-2014) for the same countries with NRA VMS effort.

Catch ('000 Kg)		Year							
Division	**Country**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**Total**
3L	Spain	2757	3074	2505	2600	2901	2996	2778	19611
	Portugal	1499	1222	1568	1592	1293	1517	1306	9997
	Russia	1176	1273	1347	1511	1337	1303	1295	9242
	Estonia	234	257	385	168	86	357	336	1823
	Faroe Islands	215	206	206	217	104	390	120	1458
Total 3L		**5881**	**6032**	**6011**	**6088**	**5721**	**6563**	**5835**	**42131**
3M	Spain	1404	1131	1419	1071	972	850	700	7547
	Portugal	407	497	627	667	644	436	569	3847
	Russia	154	82	89	36	143	131	116	751
	Estonia	4	41	56	109	28	273	101	612
	Faroe Islands			5	4	42	2		53
Total 3M		**1969**	**1751**	**2196**	**1887**	**1829**	**1692**	**1486**	**12810**
3N	Spain	431	300	626	996	794	481	698	4326
	Portugal	58	87	55	232	111	162	61	766
	Russia	213	260	78	79	63	35		728
	Estonia	61	1		1	151	98	85	397
	Faroe Islands			0	0	1			1
Total 3N		**763**	**648**	**759**	**1308**	**1120**	**776**	**844**	**6218**
3O	Portugal	12	269	7	2	3	9	2	304
	Spain	6	23	34	12	27	1		103
	Russia				1				1
	Faroe Islands			1					1
	Estonia			0		1			1
Total 3O		**18**	**292**	**42**	**15**	**31**	**10**	**2**	**410**
Total		**8631**	**8723**	**9008**	**9298**	**8701**	**9041**	**8167**	**61569**

Table 4. NRA GHL commercial LPUE, the EU 3NO, 3L and Flemish cap surveys mean weight per tow (MWPT) and Rsquare between the countries LPUE and the appropriated UE survey CPUE.

LPUE(Ton/Hour)		Year								
Division	Country	2008	2009	2010	2011	2012	2013	2014	2015	Rsquare
3L	Spain	0.303	0.285	0.196	0.218	0.218	0.402	0.389		0.280
	Portugal	0.260	0.160	0.146	0.147	0.118	0.207	0.201		0.589
	Russia	0.483	0.377	0.360	0.341	0.289	0.140	0.153		0.229
	Estonia	0.114	0.143	0.143	0.110	0.129	0.218	0.216		0.198
	Faroe Islands	0.321	0.290	0.351	0.184	0.143	0.528	0.265		0.296
Survey	3L	24.402	20.753	23.413	14.614	14.674	17.312	24.090		
3M	Spain	0.271	0.253	0.342	0.199	0.181	0.326	0.297		-0.112
	Portugal	0.140	0.141	0.144	0.122	0.105	0.159	0.150		0.091
	Russia	0.173	0.222	0.096	0.118	0.112	0.085	0.154		0.797
	Estonia	0.011	0.089	0.073	0.083	0.171	0.214	0.129		-0.852
	Faroe Islands	0.000	0.000	0.138	0.043	0.134	0.032	0.000		-0.635
Survey	FC	32.350	29.440	22.130	26.153	19.197	19.110	23.921		
3N	Spain	0.534	0.287	0.312	0.339	0.285	0.398	0.474		-0.528
	Portugal	0.196	0.165	0.117	0.134	0.160	0.195	0.127		-0.325
	Russia	0.696	0.909	0.276	0.469	0.227	0.174	0.000		0.510
	Estonia	0.613	0.100	0.000	0.047	0.254	0.334	0.264		-0.550
	Faroe Islands	0.000		0.000	0.000	0.166	0.000			-0.170
Survey	3NO	7.661	14.782	14.796	7.093	7.373	5.463	6.239		
3O	Portugal	0.038	1.414	0.063	0.019	0.018	0.042	0.008		
	Spain	0.059	0.170	0.149	0.068	0.101	0.019	0.000		
	Russia	0.000	0.000	0.000	0.062	0.000	0.000	0.000		
	Faroe Islands	0.000				0.000	0.000			
	Estonia					0.044	0.000	0.000		
Survey	3NO	7.661	14.782	14.796	7.093	7.373	5.463	6.239		

Table 5. One Country NRA GHL commercial LPUE, the Scientific Observers CPUE (Obs CPUE) and the EU 3NO, 3L and Flemish cap surveys mean weight per tow (MWPT) and Rsquare between the Survey CPUE and the Observers CPUE and commercial LPUE.

CPUE															R square	
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015		Survey-CPUE	Survey-LPUE
3L															0.76	0.40
	3L Sur			15.32	16.64	24.40	20.75	23.41	14.61	14.67	17.31	24.09	23.90			
	Obs CPUE	0.18	0.21	0.33	0.64	0.69	0.80	0.94								
	LPUE					0.303	0.285	0.196	0.218	0.218	0.402	0.389	0.413			
3M															0.71	0.56
	FC Sur	23.33	16.71	19.17	25.10	32.35	29.44	22.13	26.15	19.20	19.11	23.92	47.18			
	Obs CPUE	0.19	0.19	0.29	0.59	0.67	0.74	0.73								
	LPUE					0.271	0.253	0.342	0.199	0.181	0.326	0.297	0.421			
3N															0.10	-0.43
	3NO Sur	3.68	3.39	3.03	3.98	7.66	14.78	14.80	7.09	7.37	5.46	6.24	9.49			
	Obs CPUE	0.23	0.18	0.13	0.48	0.57	0.12	0.43								
	LPUE					0.53	0.29	0.31	0.34	0.29	0.40	0.47	0.54			
3O																
	3NO Sur	3.68	3.39	3.03	3.98	7.66	14.78	14.80	7.09	7.37	5.46	6.24	9.49			
	Obs CPUE	0.00	0.01	0.00	0.03	0.09	0.00	0.05								
	LPUE					0.06	0.17	0.15	0.07	0.10	0.02	0.00	0.00			

Table 6. One Country NRA NAFO Observers effort (hours).

NAFO Obs Effort		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3L		43344	28548	21761	11108	8448	8483	9725	8054	10144	6019	6127	4852
3M		20674	19351	9312	4969	4738	3763	3140	4525	3827	1960	1781	2201
3N		10253	5635	3614	1742	1153	1362	3186	3931	4221	1607	1845	1194
3O		540	2055	1924	874	483	757	744	124	142	24	14	25
Total xeral		74812	55589	36611	18693	14822	14364	16795	16634	18334	9610	9767	8272

Table 7. New commercials Scientific Observers estimated CPUEs through the surveys regression.

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3L				0.522	0.567	0.832	0.708	0.798	0.498	0.500	0.590	0.821	0.815
3M				0.399	0.522	0.673	0.612	0.460	0.544	0.399	0.397	0.498	0.981
3N				0.204	0.268	0.516	0.996	0.997	0.478	0.497	0.368	0.421	0.639
3O				0.204	0.268	0.516	0.996	0.997	0.478	0.497	0.368	0.421	0.639

Table 8. One country estimated catches (Tons) through the New Observers estimated CPUE and the VMS effort at more than 700 meters.

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3L						7559	7635	10185	5931	6647	4402	5866	5036
3M						3485	2734	1912	2931	2145	1035	1173	2965
3N						417	1042	1999	1403	1384	445	619	580
3O						52	135	227	85	133	20	5	151
Total						11513	11546	14323	10349	10309	5902	7662	8732

Table 9. One country estimated catches through the New Observers regression estimated CPUE and by the NAFO Observers effort at more than 700 meters.

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3L				11368	6303	7029	6002	7763	4012	5075	3553	5033	3955
3M				3713	2594	3188	2304	1445	2462	1528	779	886	2160
3N				738	467	595	1357	3177	1879	2098	592	776	764
3O				393	234	249	754	742	59	71	9	6	16
Total				16212	9599	11062	10417	13128	8412	8771	4932	6701	6894

Table 10. One country SC approved GHL catches estimated based on the “real” Scientific Observers CPUEs and the NAFO Observers effort at more than 700 meters.

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
3L		7782	5882	7286	7117	5800	6818	9097					
3M		4017	3627	2716	2955	3178	2797	2305					
3N		2331	1001	480	831	655	160	1365					
3O		0	24	7	25	43	1	35					
Total		14130	10535	10489	10927	9676	9776	12802					

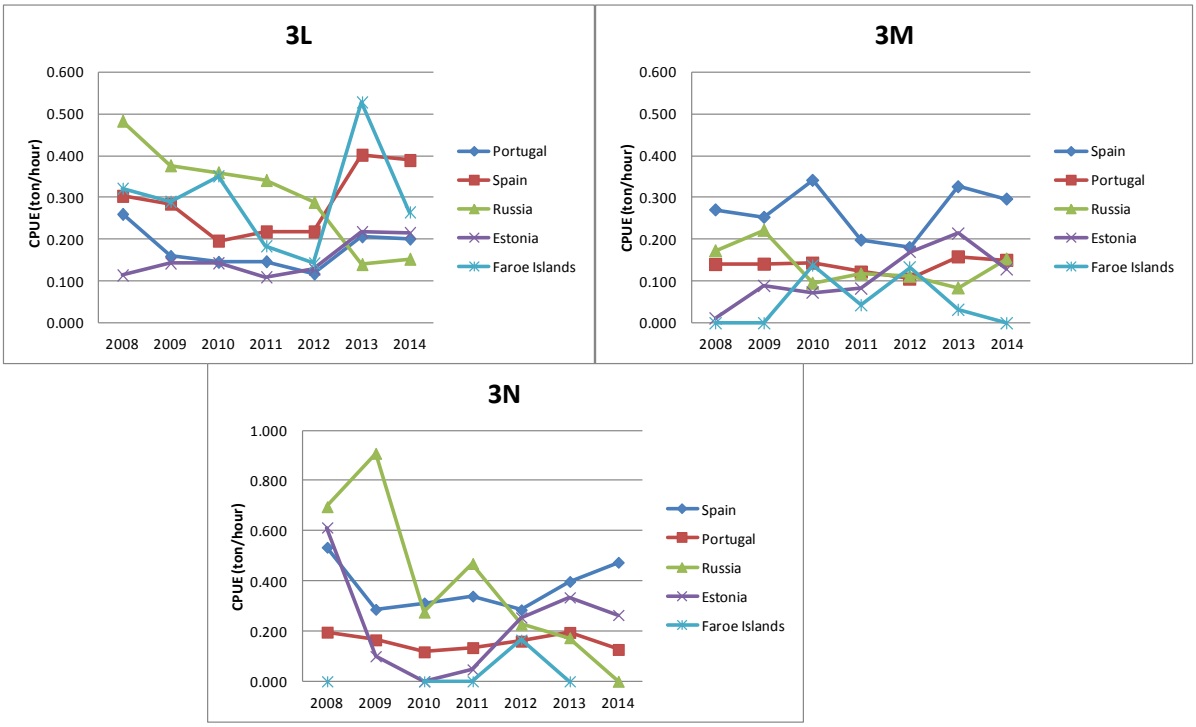

Fig. 1. NRA Greenland halibut Commercial LPUE (STATLANT 21A tons/VMS effort hours) by country and Division.

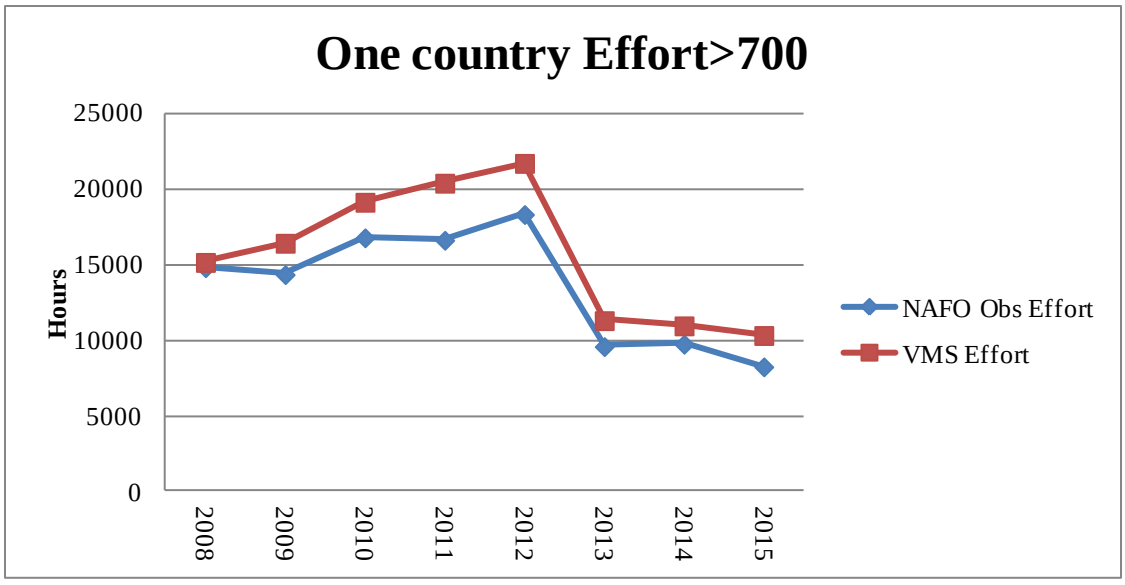

Fig. 2. One country VMS estimated effort and NAFO Observers effort at more than 700 meters depth.

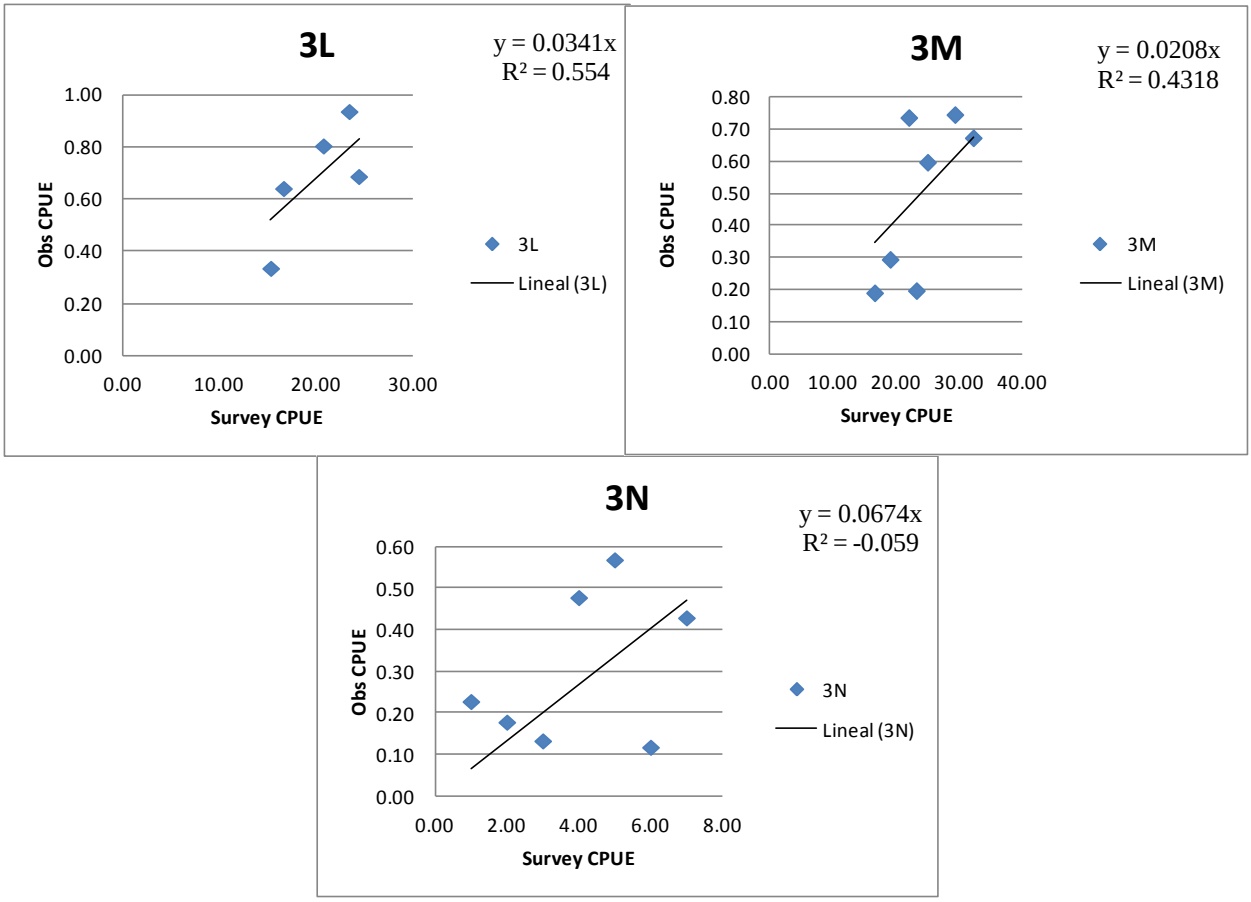

Fig. 3. The regression line between the Surveys CPUEs and the Scientific Observers CPUEs with the 2004-2010 data and their regression equation and the Rsquare.

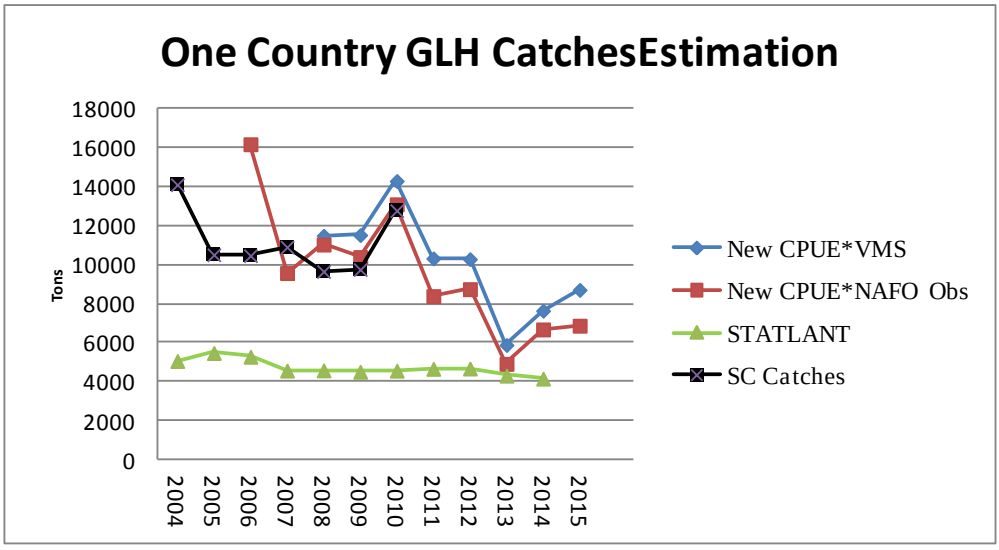

Fig. 4. One country GHL estimated catches through the new estimated CPUE with the VMS effort (blue) and the NAFO Observers effort at more than 700 meters (brow), the SC GHL approved catches (black) as well as the GHL STATLANT catches (green).

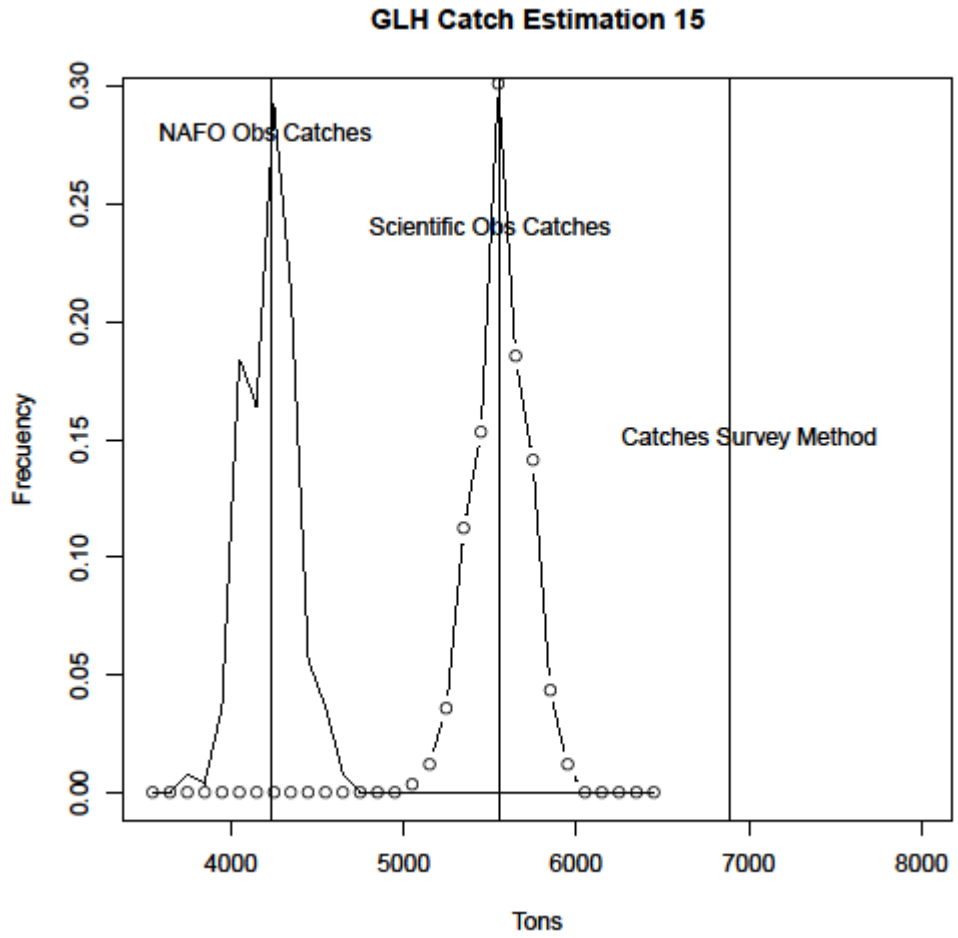

Fig. 5. GHL NAFO Observers catches, Scientific Observers catches estimation and their uncertainty estimated by Bootstrap as well as the catches estimation through the method using the regression between the commercial and surveys CPUEs.