

COMBINED INDICES OF ABUNDANCE OF BLUE SHARKS IN THE NORTH AND SOUTH ATLANTIC OCEAN

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SUMMARY

Indices of relative abundance (CPUEs) available for the stock assessments of blue shark (Prionace glauca) in the North Atlantic and South Atlantic Ocean were combined using different methods. Following the work conducted for the 2008 SCRS blue shark stock assessment, indices were combined through a GLM with two choices of weighting: by the catch of the flag represented by each index and by the area of the flag represented by each index. Additionally, a hierarchical index of abundance that combines all available indices into a single series was also developed. The three indices obtained for the North Atlantic and South Atlantic generally followed very similar trends, with a flat tendency in the North Atlantic and an increasing trend in the South Atlantic. These indices can potentially be used in sensitivity analyses in the stock assessments.

RÉSUMÉ

Les indices d'abondance relative (CPUE) disponibles pour les évaluations de stocks de requin peau bleue (Prionace glauca) de l'Atlantique Nord et Sud ont été combinés au moyen de différentes méthodes. Conformément aux travaux réalisés pour l'évaluation du stock de requin peau bleue de 2008, les indices ont été combinés au moyen d'un GLM avec deux choix de pondération : par la prise du pavillon représentée par chaque indice et par la zone du pavillon représentée par chaque indice. De plus, un indice hiérarchique d'abondance combinant tous les indices disponibles dans une seule série a également été créé. Les trois indices obtenus pour l'Atlantique Nord et l'Atlantique Sud affichaient généralement des tendances très similaires, avec une tendance aplaniée dans l'Atlantique Nord et une tendance ascendante dans l'Atlantique Sud. Ces indices peuvent éventuellement être utilisés dans des analyses de sensibilité dans les évaluations de stocks.

RESUMEN

Los índices de abundancia relativa (CPUE) disponibles para las evaluaciones de stock de tintorera (Prionace glauca) en el Atlántico norte y el Atlántico sur se combinaron utilizando diferentes métodos. Tras el trabajo realizado para la evaluación del stock de tintorera del SCRS de 2008, se combinaron los índices mediante un GLM con dos opciones de ponderación: por la captura del pabellón representado por cada índice y por el área del pabellón representado por cada índice. Además, se desarrolló también un índice de abundancia jerárquico que combina todos los índices disponibles en una serie única. Los tres índices obtenidos para el Atlántico norte y sur seguían en general tendencias muy similares, con una tendencia plana en el Atlántico norte y una tendencia ascendente en el Atlántico sur en los años recientes de la serie temporal. Estos índices pueden ser potencialmente utilizados en análisis de sensibilidad en las evaluaciones de stock.

KEYWORDS

Time series analysis, stock assessment, abundance, fishing effort, catch statistics, shark fisheries, pelagic fisheries, blue shark

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1. Introduction

In the 2008 Blue Shark and Shortfin Mako Stock Assessment meeting, the Working Group decided to develop combined indices as overall indicators of relative abundance (Anon. 2009). The indices available at the time were combined through a GLM approach using two choices of weighting: by area fished and by catch. Following that approach, combined abundance indices were generated for the North and South Atlantic using both area fished (using hooks as a proxy) and catch series developed at the 2015 Blue Shark Data Preparatory meeting (Anon. 2015 *in press*). Additionally, a hierarchical index was also developed for the North and South Atlantic that combines all the available CPUEs into a single time series (Conn 2010). The rationale for using this method is that the individual indices attempt to estimate relative abundance but are subject to both sampling and process error. While sampling error is assumed to be captured by previous (GLM) standardization of the indices through the CVs, each index is also subject to process variation, which describes the degree to which a given index measures “artifacts” above and beyond abundance in the population. As a whole, all these combined indices have the advantage of providing a single signal to the stock assessment model and can be used in sensitivity analyses if deemed adequate by the Working Group.

2. Materials and methods

2.1 Data

Annual weights for the CPUE series were computed using catch by flag (method 1) or area fished (method 2). To calculate area, the most recent 5x5 degree data on longline hooks prepared by the Subcommittee on Ecosystems (P. de Bruyn, pers. comm.), which included data up to 2009, were used. Values for 2010-2013 were assumed to be the mean of the last five years of data (2005-2009). Annual weights were then computed as follows: first, annual catches or effort of the flags represented by CPUE series (Tables 6 and 7 of the 2015 Blue Shark Data Preparatory meeting) were expressed as proportions, then for each flag, if the year for which catch (effort) was available also had an index value (Table 8 of the 2015 Blue Shark Data Preparatory meeting), the catch (effort) was expressed as a proportion of the total, which summed to 1. Annual weights based on catch and area for each of the CPUE series considered for the North Atlantic and South Atlantic stock assessments are included in **Table 1** and **Table 2**. Additionally, annual index values with the associated CVs were used in the hierarchical analysis of CPUEs (method 3). All values used are listed in **Table 3** (indices) and **Table 4** (CVs used in method 3).

2.2 Analysis

For methods 1 and 2, relative abundance indices were estimated using a Generalized Linear Modeling (GLM) approach assuming a normal distribution (identity link) on log-transformed catch rates and applying a back-transformed log bias correction. Year and CPUE series were explanatory variables and the weights computed above were used to weight the GLM. For method 3, relative abundance indices were computed using a Bayesian approach (see Conn 2010 for details).

3. Results and discussion

The three methods yielded similar time trajectories of relative abundance (**Figure 1**). For the North Atlantic all trajectories followed the same general trend, with the noticeable exception of a dip for the effort-weighted index in 2002, but despite fluctuations the series were relatively stable over the entire time trajectory (**Figure 1 top**). For the South Atlantic, the effort-weighted index showed more extreme fluctuations, especially in the latter part of the time series, and all series showed an accentuated increasing tendency since the mid-1990s (**Figure 1 bottom**). The individual indices for the North Atlantic are summarized in **Table 5** and those for the South Atlantic in **Table 6**.

References

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- Anon. *In press*. SCRS/2015/013. Report of the 2015 Blue Shark Data Preparatory Meeting. Tenerife, Spain, March 23-27, 2015. 35 pp.
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Table 1. Weights based on relative catch used for weighting CPUE indices for the North and South Atlantic stocks.

Year	Catch-weights		North Atlantic						Catch-weights		South Atlantic			
	Usobs	JPLLe	JPLLI	USOLD	PORLL	VENLL	ESPLL	CHTPLL	URULL	BROLL	JPLLe	JPLLI	ESPLL	CHTPLL
1957				1										
1958				1										
1959				1										
1960				1										
1961				1										
1962				1										
1963				1										
1964				1										
1965				1										
1966				1										
1967				1										
1968				1										
1969				1										
1970				1										
1971		1									1			
1972		1									1			
1973		1									1			
1974		1									1			
1975		1									1			
1976		1									1			
1977		1									1			
1978		1								0.030	0.970			
1979		1								0.037	0.963			
1980		1								0.093	0.907			
1981		0.969		0.031						0.077	0.923			
1982		0.972		0.028						0.057	0.943			
1983		0.851		0.149						0.136	0.864			
1984		0.958		0.042						0.034	0.966			
1985		0.915		0.085						0.049	0.951			
1986		0.725		0.275						0.052	0.948			
1987		0.680		0.320						0.102	0.898			
1988		0.755		0.245						0.086	0.914			
1989		0.858		0.142						0.088	0.912			
1990		0.813		0.187						0.106	0.894			
1991		0.768		0.232						0.102	0.898			
1992	0.081	0.919							0.017	0.233	0.750			
1993	0.234	0.766							0.009	0.126	0.865			

1994	0.191		0.803			0.006				0.010	0.103		0.887		
1995	0.185		0.811			0.005				0.008	0.165		0.826		
1996	0.191		0.808			0.001				0.042	0.173		0.785		
1997	0.012		0.132		0.083	0.001	0.772			0.015	0.190		0.361	0.433	
1998	0.015		0.120		0.085	0.000	0.780			0.021	0.185		0.318	0.476	
1999	0.012		0.114		0.081	0.002	0.792			0.009	0.204		0.239	0.548	
2000	0.015		0.096		0.071	0.001	0.817			0.007	0.144		0.253	0.596	
2001	0.006		0.122		0.094	0.002	0.776			0.006	0.187		0.143	0.665	
2002	0.003		0.095		0.114	0.001	0.787			0.010	0.222		0.163	0.605	
2003	0.000		0.125		0.228	0.002	0.645			0.033	0.147		0.371	0.449	
2004	0.003		0.133		0.084	0.000	0.722	0.057		0.025	0.092		0.147	0.405	0.330
2005	0.003		0.150		0.171	0.001	0.638	0.036		0.023	0.158		0.104	0.400	0.315
2006	0.002		0.123		0.188	0.001	0.671	0.016		0.013	0.150		0.190	0.505	0.141
2007	0.002		0.091		0.212	0.001	0.683	0.012		0.019	0.149		0.206	0.504	0.123
2008	0.005		0.105		0.203	0.000	0.684	0.004		0.019	0.104		0.285	0.497	0.095
2009	0.003		0.087		0.184	0.002	0.721	0.002		0.046	0.062		0.184	0.641	0.066
2010	0.005		0.074		0.221	0.002	0.697	0.003		0.009	0.066		0.236	0.617	0.072
2011	0.007		0.058		0.175	0.003	0.753	0.004			0.076		0.163	0.651	0.082
2012	0.005		0.064		0.107	0.003	0.818	0.003			0.070		0.193	0.624	0.093
2013	0.008		0.040		0.108	0.002	0.839	0.004					0.216	0.644	0.141

Table 2. Weights based on relative area used for weighting CPUE indices for the North and South Atlantic stocks.

Year	Area-weights		North Atlantic						Area-weights		South Atlantic			
	Usobs	JPLLe	JPLLI	USOLD	PORLL	VENLL	ESPLL	CHTPLL	URULL	BRLL	JPLLe	JPLLI	ESPLL	CHTPLL
1957				1										
1958				1										
1959				1										
1960				1										
1961				1										
1962				1										
1963				1										
1964				1										
1965				1										
1966				1										
1967				1										
1968				1										
1969				1										
1970				1										
1971		1									1			
1972		1									1			
1973		1									1			
1974		1									1			
1975		1									1			
1976		1									1			
1977		1									1			
1978		1								0.030	0.970			
1979		1								0.037	0.963			
1980		1								0.093	0.907			
1981		0.969		0.031						0.077	0.923			
1982		0.972		0.028						0.057	0.943			
1983		0.851		0.149						0.136	0.864			
1984		0.958		0.042						0.034	0.966			
1985		0.915		0.085						0.049	0.951			
1986		0.725		0.275						0.052	0.948			
1987		0.680		0.320						0.102	0.898			
1988		0.755		0.245						0.086	0.914			
1989		0.858		0.142						0.088	0.912			
1990		0.813		0.187						0.106	0.894			
1991		0.768		0.232						0.102	0.898			
1992	0.081	0.919							0.017	0.233	0.750			
1993	0.234	0.766							0.009	0.126	0.865			

1994	0.191		0.803			0.006				0.010	0.103		0.887		
1995	0.185		0.811			0.005				0.008	0.165		0.826		
1996	0.191		0.808			0.001				0.042	0.173		0.785		
1997	0.012		0.132		0.083	0.001	0.772			0.015	0.190		0.361	0.433	
1998	0.015		0.120		0.085	0.000	0.780			0.021	0.185		0.318	0.476	
1999	0.012		0.114		0.081	0.002	0.792			0.009	0.204		0.239	0.548	
2000	0.015		0.096		0.071	0.001	0.817			0.007	0.144		0.253	0.596	
2001	0.006		0.122		0.094	0.002	0.776			0.006	0.187		0.143	0.665	
2002	0.003		0.095		0.114	0.001	0.787			0.010	0.222		0.163	0.605	
2003	0.000		0.125		0.228	0.002	0.645			0.033	0.147		0.371	0.449	
2004	0.003		0.133		0.084	0.000	0.722	0.057		0.025	0.092		0.147	0.405	0.330
2005	0.003		0.150		0.171	0.001	0.638	0.036		0.023	0.158		0.104	0.400	0.315
2006	0.002		0.123		0.188	0.001	0.671	0.016		0.013	0.150		0.190	0.505	0.141
2007	0.002		0.091		0.212	0.001	0.683	0.012		0.019	0.149		0.206	0.504	0.123
2008	0.005		0.105		0.203	0.000	0.684	0.004		0.019	0.104		0.285	0.497	0.095
2009	0.003		0.087		0.184	0.002	0.721	0.002		0.046	0.062		0.184	0.641	0.066
2010	0.005		0.074		0.221	0.002	0.697	0.003		0.009	0.066		0.236	0.617	0.072
2011	0.007		0.058		0.175	0.003	0.753	0.004			0.076		0.163	0.651	0.082
2012	0.005		0.064		0.107	0.003	0.818	0.003			0.070		0.193	0.624	0.093
2013	0.008		0.040		0.108	0.002	0.839	0.004					0.216	0.644	0.141

Table 3. Indices of abundance for North and South Atlantic blue shark stocks used for developing the combined indices through the three methods.

Year	Usobs	North Atlantic				PORLL	VENLL	ESPLL	CHTPLL		South Atlantic				
		JPLLe	JPLLI	USOLD							URULL	BRLL	JPLLe	JPLLI	ESPLL
1957				0.98											
1958				0.48											
1959				1.11											
1960				1.18											
1961				1.13											
1962				1.5											
1963				0.7											
1964				0.87											
1965				1.55											
1966				1.27											
1967				1.43											
1968				1.31											
1969				1.96											
1970				0.97											
1971		0.87		1.08								1.32			
1972		1.46		1.93								0.87			
1973		1.12										1.94			
1974		2.62										1.28			
1975		1.85		0.88								1.29			
1976		1.07		0.75								1.58			
1977		1.89		1.82								7.48			
1978		1.58		1.06							0.094	4.51			
1979		1.3		0.860							0.441	4.45			
1980		2.21		0.830							0.614	4.52			
1981		2.19		1.050							0.338	1.52			
1982		2.08		0.780							0.543	3.18			
1983		1.81		1.010							0.362	2.69			
1984		1.22		0.680							0.532	3.07			
1985		1.51		0.740							1.005	2.54			
1986		1.52		0.480							0.896	3.18			
1987		2.13		0.500							0.723	3.13			
1988		1.21		0.440							0.861	3.14			
1989		1.51		0.800							0.878	2.28			
1990		1.34		0.940							0.893	2.31			
1991		1.26		1.220							0.202	2.23			
1992	7.455	1.9		0.63						138.8	0.805	2.27			
1993	11.076	2.43		0.95						24.6	0.143	2.17			

1994	9.717		2.33	0.98		0.047				311.2	0.558		1.48		
1995	10.17		2.1	0.73		0.073				81.9	0.272		0.96		
1996	8.208		2.05	0.47		0.017				346.7	0.132		1.07		
1997	14.439		2.05	1.25	158.14	0.154	156.83			351.0	0.493		1.33	330.6	
1998	18.408		1.72	1.16	169.02	0.216	154.45			315.7	1.336		1.25	349.4	
1999	6.663		1.89	0.76	149.83	0.117	179.91			182.8	0.469		1.23	352.4	
2000	9.541		1.58	0.78	201.44	0.151	213.05			166.1	0.455		0.82	435.1	
2001	2.306		1.71		222.14	0.133	215.63			99.1	1.984		1.02	389.1	
2002	2.277		1.37		200.86	0.074	183.94			72.7	1.175		1.03	361.5	
2003	1.876		1.97		238.77	0.044	222.88			99.7	2.725		1.82	326.3	
2004	9.503		1.79		266.16	0.034	177.27	0.749		107.3	3.568		1.21	325.3	0.28
2005	3.193		1.9		218.55	0.006	166.82	2.195		116.4	2.898		1.18	369.6	0.82
2006	4.674		2.16		212.63	0.013	177.11	1.308		111.0	3.260		1.35	369.2	2.31
2007	9.645		2.18		241.32	0.060	187.06	0.561		296.4	3.187		1.32	380.0	0.90
2008	8.512		2.48		225.68	0.088	215.80	0.495		250.1	2.501		1.81	359.3	1.12
2009	8.322		2.46		228.30	0.045	196.08	0.570		130.6	4.456		1.49	394.5	0.88
2010	13.545		2.45		276.76	0.040	209.03	0.877		436.5	4.966		1.94	379.2	1.35
2011	21.806		2.37		233.29	0.044	221.13	0.765			3.206		1.34	386.9	0.87
2012	8.128		2.6		305.53	0.107	238.00	0.668			1.769		1.49	400.9	1.40
2013	7.374		2.09		304.08	0.044	203.49	1.045					2.17	418.0	1.61

Table 4. Coefficients of variation (CVs) for North and South Atlantic blue shark stocks used for developing the hierarchical index of abundance through method 3.

Year	Usobs	North Atlantic							South Atlantic					
		JPLLe	JPLLI	USOLD	PORLL	VENLL	ESPLL	CHTPLL	URULL	BROLL	JPLLe	JPLLI	ESPLL	CHTPLL
1957				0.17										
1958				0.16										
1959				0.25										
1960				0.38										
1961				0.35										
1962				0.27										
1963				0.25										
1964				0.17										
1965				0.17										
1966				0.23										
1967				0.21										
1968				0.21										
1969				0.22										
1970				0.32										
1971		0.53		0.23								0.48		
1972		0.39		0.21								0.56		
1973		0.45										0.35		
1974		0.32										0.39		
1975		0.34		0.19								0.26		
1976		0.47		0.29								0.06		
1977		0.27		0.2								0.01		
1978		0.32		0.11							0.65	0.08		
1979		0.24		0.11							0.72	0.13		
1980		0.29		0.09							0.73	0.18		
1981		0.36		0.09							0.88	0.44		
1982		0.36		0.09							0.86	0.34		
1983		0.37		0.1							0.86	0.22		
1984		0.50		0.1							0.65	0.34		
1985		0.44		0.1							0.69	0.41		
1986		0.39		0.09							0.63	0.37		
1987		0.35		0.1							0.60	0.37		
1988		0.49		0.12							0.65	0.37		
1989		0.44		0.39							0.61	0.47		
1990		0.49		0.17							0.74	0.48		
1991		0.47		0.11							0.56	0.49		
1992	0.31	0.43		0.1						0.63	0.61	0.44		
1993	0.29	0.40		0.09						1.20	0.72	0.49		

1994	0.29		0.50	0.1		1.08			0.62	0.57		0.43		
1995	0.29		0.55	0.1		0.87			0.90	0.58		0.50		
1996	0.50		0.51	0.3		1.90			0.57	0.64		0.45		
1997	0.33		0.52	0.13	0.084		0.008		0.54	0.57		0.43	0.006	
1998	0.35		0.53	0.15	0.076	0.67	0.008		0.54	0.60		0.39	0.007	
1999	0.34		0.49	0.13	0.077	0.84	0.008		0.51	0.54		0.42	0.006	
2000	0.32		0.28	0.12	0.083	0.74	0.008		0.60	0.54		0.45	0.006	
2001	0.39		0.56		0.089	0.77	0.008		0.63	0.60		0.39	0.005	
2002	0.39		0.62		0.086	1.03	0.008		0.67	0.58		0.35	0.006	
2003	0.37		0.59		0.082	1.26	0.009		0.65	0.65		0.25	0.006	
2004	0.30		0.69		0.084	1.53	0.009	0.12	0.61	0.55		0.41	0.007	0.23
2005	0.35		0.71		0.087	3.88	0.010	0.19	0.55	0.55		0.41	0.007	0.10
2006	0.31		0.69		0.084	2.24	0.010	0.06	0.56	0.54		0.42	0.007	0.04
2007	0.32		0.61		0.085	1.35	0.011	0.22	0.51	0.65		0.44	0.007	0.06
2008	0.32		0.69		0.085	1.16	0.011	0.28	0.51	0.66		0.39	0.007	0.07
2009	0.31		0.64		0.086	1.56	0.012	0.17	0.51	0.58		0.41	0.006	0.06
2010	0.31		0.64		0.089	1.54	0.010	0.10	0.53	0.54		0.36	0.007	0.06
2011	0.29		0.51		0.079	1.51	0.010	0.12		0.50		0.44	0.007	0.05
2012	0.34		0.51		0.081	1.00	0.010	0.11		0.58		0.43	0.007	0.06
2013	0.31		0.21		0.085	1.84	0.011	0.14				0.34	0.007	0.04

Table 5. Combined indices of relative abundance for the North Atlantic based on catch weighting, area weighting, and hierarchical analysis.

Year	Catch-weighted		Effort-weighted		Hierarchical	
	Index	CV	Index	CV	Index	CV
1957	4.440	0.164	4.862	0.258	0.954	0.329
1958	2.175	0.164	2.381	0.258	0.494	0.326
1959	5.029	0.164	5.507	0.258	1.071	0.368
1960	5.346	0.164	5.854	0.258	1.125	0.445
1961	5.119	0.164	5.606	0.258	1.092	0.426
1962	6.796	0.164	7.441	0.258	1.394	0.377
1963	3.171	0.164	3.473	0.258	0.709	0.372
1964	3.942	0.164	4.316	0.258	0.855	0.331
1965	7.022	0.164	7.689	0.258	1.449	0.326
1966	5.754	0.164	6.300	0.258	1.205	0.352
1967	6.479	0.164	7.094	0.258	1.343	0.344
1968	5.935	0.164	6.499	0.258	1.240	0.344
1969	8.880	0.164	9.723	0.258	1.779	0.348
1970	4.395	0.164	4.812	0.258	0.955	0.410
1971	1.786	0.154	2.055	0.243	0.832	0.311
1972	2.998	0.154	3.449	0.243	1.298	0.296
1973	2.300	0.154	2.646	0.243	0.648	0.477
1974	5.379	0.154	6.189	0.243	1.303	0.385
1975	3.798	0.154	4.370	0.243	0.891	0.266
1976	2.197	0.154	2.528	0.243	0.676	0.317
1977	3.881	0.154	4.464	0.243	1.290	0.271
1978	3.244	0.154	3.919	0.243	0.937	0.247
1979	2.669	0.154	3.246	0.243	0.756	0.235
1980	4.538	0.154	5.060	0.243	0.912	0.246
1981	4.504	0.154	5.174	0.243	1.038	0.249
1982	4.247	0.154	4.744	0.243	0.838	0.255
1983	3.832	0.154	4.416	0.243	0.956	0.250
1984	2.526	0.154	2.974	0.243	0.661	0.266
1985	3.121	0.154	3.584	0.243	0.737	0.260
1986	2.824	0.154	3.140	0.243	0.550	0.268
1987	3.542	0.155	3.976	0.243	0.644	0.279
1988	2.353	0.154	2.558	0.244	0.482	0.275
1989	3.169	0.154	3.691	0.243	0.793	0.342
1990	2.985	0.154	3.530	0.243	0.850	0.283
1991	3.084	0.154	3.518	0.243	1.017	0.268
1992	3.863	0.146	4.353	0.201	0.727	0.261
1993	5.026	0.133	5.819	0.191	1.035	0.248
1994	4.729	0.102	4.193	0.226	1.004	0.247
1995	4.396	0.102	4.346	0.241	0.831	0.256
1996	4.130	0.102	3.561	0.229	0.669	0.305
1997	3.461	0.106	3.964	0.169	0.900	0.153
1998	3.376	0.106	3.785	0.169	0.905	0.152
1999	3.759	0.106	3.564	0.169	0.902	0.165
2000	4.367	0.106	3.676	0.168	1.089	0.160
2001	4.393	0.106	2.988	0.168	1.168	0.157
2002	3.784	0.106	2.388	0.167	1.016	0.156
2003	4.600	0.106	2.677	0.182	1.214	0.156
2004	3.812	0.104	3.614	0.167	1.123	0.174
2005	3.804	0.104	3.646	0.168	1.016	0.165
2006	3.911	0.105	3.807	0.167	1.038	0.159
2007	4.121	0.106	4.018	0.166	1.115	0.162
2008	4.565	0.106	4.271	0.167	1.182	0.156
2009	4.272	0.106	4.117	0.166	1.122	0.157
2010	4.661	0.106	4.719	0.167	1.265	0.163
2011	4.689	0.106	4.963	0.167	1.232	0.155
2012	5.169	0.106	4.613	0.167	1.406	0.159
2013	4.477	0.107	4.077	0.167	1.272	0.170

Table 6. Combined indices of relative abundance for the South Atlantic based on catch weighting, area weighting, and hierarchical analysis.

Year	Catch-weighted		Effort-weighted		Hierarchical	
	Index	CV	Index	CV	Index	CV
1971	1.936	0.285	1.499	0.284	0.384	0.544
1972	1.276	0.285	0.988	0.284	0.295	0.601
1973	2.845	0.285	2.202	0.284	0.493	0.468
1974	1.877	0.285	1.453	0.284	0.357	0.507
1975	1.892	0.285	1.465	0.284	0.336	0.443
1976	2.317	0.285	1.794	0.284	0.382	0.376
1977	10.970	0.285	8.492	0.284	1.622	0.325
1978	6.192	0.282	4.136	0.275	0.859	0.328
1979	6.364	0.281	4.854	0.277	0.939	0.322
1980	6.409	0.275	5.067	0.278	0.972	0.341
1981	2.252	0.277	1.761	0.278	0.408	0.465
1982	4.629	0.279	3.619	0.277	0.723	0.417
1983	3.751	0.271	2.955	0.271	0.604	0.362
1984	4.485	0.281	3.499	0.277	0.699	0.407
1985	3.857	0.280	3.021	0.279	0.685	0.447
1986	4.754	0.279	3.829	0.275	0.775	0.421
1987	4.670	0.274	3.727	0.272	0.739	0.416
1988	4.742	0.276	3.736	0.276	0.761	0.421
1989	3.551	0.276	2.786	0.276	0.643	0.467
1990	3.644	0.274	2.812	0.277	0.643	0.470
1991	3.025	0.275	2.358	0.274	0.461	0.463
1992	3.874	0.260	3.062	0.265	0.735	0.392
1993	2.751	0.270	1.949	0.263	0.395	0.438
1994	8.694	0.236	9.038	0.238	1.429	0.369
1995	5.074	0.233	5.492	0.237	0.745	0.404
1996	5.063	0.230	5.814	0.237	1.063	0.383
1997	7.490	0.224	7.733	0.232	1.325	0.220
1998	9.152	0.224	8.653	0.231	1.399	0.219
1999	7.433	0.225	7.003	0.230	1.339	0.215
2000	8.006	0.226	5.466	0.228	1.534	0.230
2001	10.462	0.227	9.436	0.227	1.435	0.219
2002	8.893	0.225	7.587	0.226	1.320	0.220
2003	10.839	0.224	12.353	0.227	1.374	0.225
2004	6.902	0.224	4.985	0.235	1.198	0.219
2005	10.917	0.223	9.836	0.232	1.397	0.212
2006	12.786	0.223	16.413	0.231	1.528	0.229
2007	11.376	0.222	10.076	0.234	1.509	0.213
2008	11.351	0.223	12.310	0.234	1.495	0.222
2009	10.975	0.224	10.483	0.233	1.525	0.211
2010	12.179	0.226	15.007	0.233	1.656	0.237
2011	10.839	0.230	10.170	0.236	1.496	0.215
2012	11.221	0.229	12.790	0.236	1.590	0.215
2013	12.784	0.229	15.910	0.240	1.733	0.227

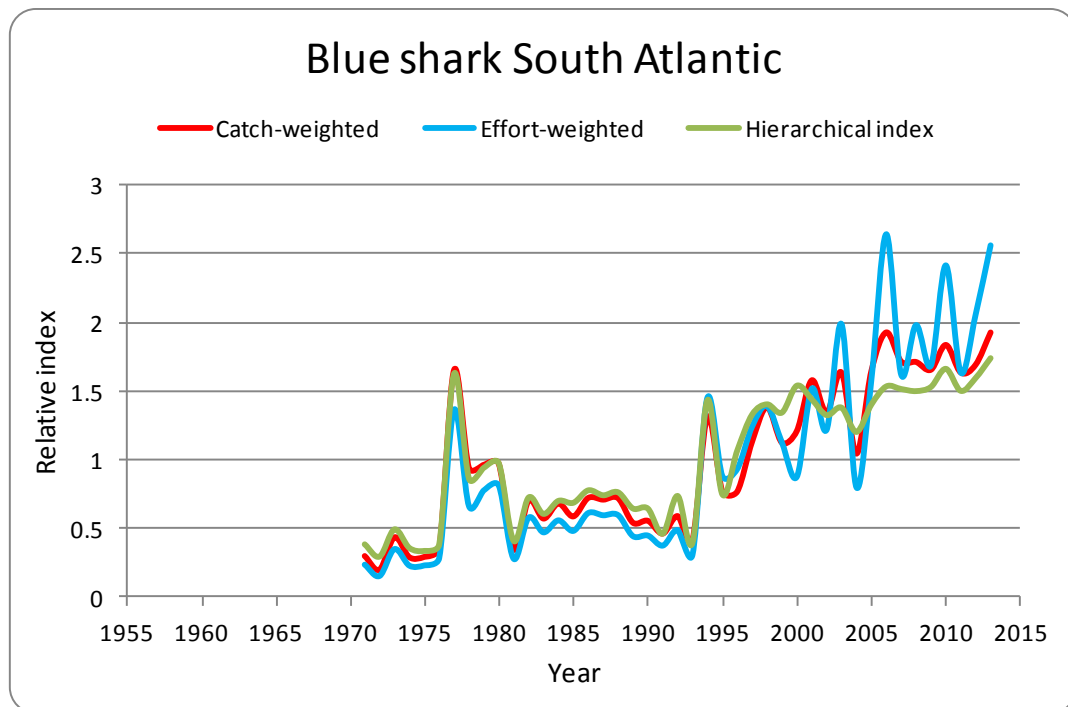
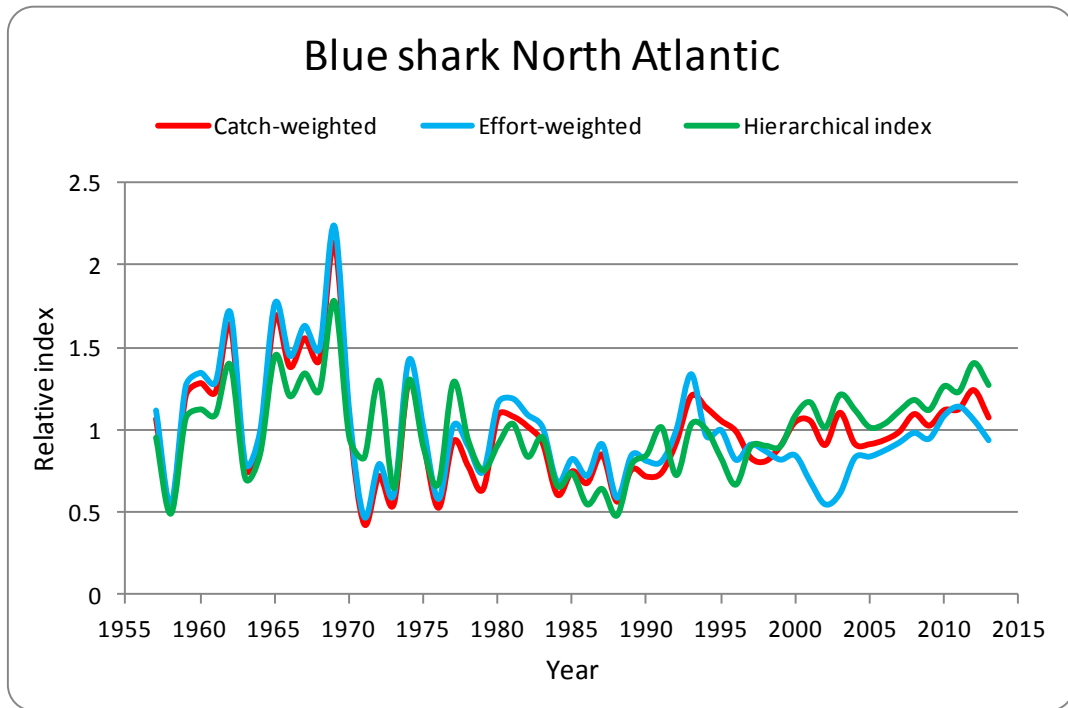


Figure 1. Combined indices of relative abundance based on catch weighting, area weighting, and hierarchical analysis: North Atlantic (top panel), South Atlantic (bottom panel).