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Update of Allocation Shares for Canada and the USA of the Transboundary Resources of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank through Fishing Year 2015

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ABSTRACT

The development of consistent management by Canada and the USA for the transboundary resources of Atlantic Cod, Haddock, and Yellowtail Flounder on Georges Bank led to a sharing allocation agreement. For Atlantic Cod and Haddock, the agreement is limited to the eastern Georges Bank management unit (Department of Fisheries and Oceans (DFO) Statistical Unit Areas 5Zj and 5Zm; United States of America (USA) Statistical Areas 551, 552, 561, and 562). The management unit for Yellowtail Flounder encompasses the entire Georges Bank east of the Great South Channel (DFO Statistical Unit Areas 5Zh, 5Zj, 5Zm, and 5Zn; USA Statistical Areas 522, 525, 551, 552, 561, and 562). Two principles are incorporated in the sharing formulae to account for both historical utilization, based on reported landings during 1967 through 1994, and temporal changes in resource distributions, determined from National Marine Fisheries Service (NMFS) and DFO survey results that are updated annually. From 2010 onward, utilization will account for 10% and distribution for 90% of the allocation. This report uses the 2013 DFO and NMFS survey results to update the calculation for the 2015 fishing year allocations.

The resource distributions in 2013 were: 83% Canada, 17% USA for Atlantic Cod; 52% Canada, 48% USA for Haddock; and 33% Canada, 67% USA for Yellowtail Flounder. The 2015 fishing year allocations (calendar year for Canada; May 1, 2015, to April 30, 2016, for the USA), updated with the 2013 resource distributions, resulted in shares for Atlantic Cod of 81% Canada, 19% USA, for Haddock of 52% Canada, 48% USA, and for Yellowtail Flounder of 30% Canada, 70% USA.

RÉSUMÉ

Introduction

The designation of units for management entails a compromise between the biological realities of stock structure and the practical convenience of analysis and policy making (Gulland 1980). For Yellowtail Flounder, Canada and the United States of America (USA) use a common management unit (for Department of Fisheries and Oceans Canada (DFO) Statistical Unit Areas 5Zh, 5Zj, 5Zm, and 5Zn; for USA Statistical Areas 522, 525, 551, 552, 561, and 562) encompassing the entire bank east of the Great South Channel (Figure 1), referred to hereafter as Georges Bank. For Atlantic Cod and Haddock, the USA employs a management unit comprising all of Georges Bank and extending south and west of Cape Cod, while Canada uses only the eastern portion of Georges Bank. The Transboundary Management Guidance Committee (TMGC) agreed that, for the purpose of developing a sharing formula for Atlantic Cod and Haddock, the management unit would be limited to the eastern portion of Georges Bank (Figure 1; DFO Statistical Unit Areas 5Zj and 5Zm; USA Statistical Areas 551, 552, 561, and 562), referred to as eastern Georges Bank.

Principles of resource sharing for transboundary stocks include consideration of access to resources occurring or produced within national boundaries and historical participation in exploitation of the resources (Gavaris and Murawski 2004). The former has emerged from the effective property rights associated with Exclusive Economic Zones as well as the distribution of stocks occurring in areas under national jurisdiction (UN 1995). The latter recognizes traditional involvement and investment in the development of a fishery. Both principles were incorporated in the TMGC sharing proposal, but historical participation gradually was down-weighted so that after an eight year phase-in period, the annual allocation would be based primarily on resource distribution (90%).

Details for calculating the national allocations for Canada and the USA were described by Murawski and Gavaris (2004). The approach incorporates both resource utilization and resource distributions relative to the USA/Canada east coast maritime boundary. Results for fishing years 2006 to 2013 have been reported annually (Stone *et al.* 2013). This report uses the 2013 USA National Marine Fisheries Service (NMFS) and DFO survey results to estimate the 2015 fishing year allocations.

Data and Methods

Formula

The TMGC (TMGC 2002) agreed approach for calculating the respective country shares that takes into consideration historical utilization and adapts to shifts in resource distribution is as follows:

$$\% \text{share}_{\text{year, country}} = (\alpha_{\text{year}} \times \% \text{utilization}_{\text{year, country}}) + (\beta_{\text{year}} \times \% \text{resource distribution}_{\text{year, country}})$$

where α_{year} = percentage weighting for utilization in year

β_{year} = percentage weighting for resource distribution in year

$$\alpha_{\text{year}} + \beta_{\text{year}} = 100\%$$

The initial sharing formula was based on the weighting of resource distribution from surveys by 60% and country utilization by 40%. Thereafter, the percentage weighting was changed in 5% annual increments until the weightings reached 90% resource distribution from surveys and 10% country utilization from landings. This agreement was implemented in 2003, with the end of the transition to a 90/10 weighting in the 2010 fishing year according to the following schedule:

Year	2003	2004	2005	2006	2007	2008	2009	2010
Weighting	60/40	60/40	65/35	70/30	75/25	80/20	85/15	90/10

Resource Utilization

Historical participation in exploitation of these resources was assessed for the three species using landings records (Table 1). The TMGC agreed to use the percentage of the total landings from 1967 to 1994, inclusive, by country, as the measure of country utilization.

Resource Distribution

Resource distribution patterns were determined from three research vessel bottom trawl survey time series conducted by the NMFS and DFO. Surveys of Georges Bank have been conducted by NMFS each fall (October) since 1963 and each spring (April) since 1968, and by DFO since 1986 (February).

Before 2009, two vessels (the former National Oceanic and Atmospheric Administration (NOAA) ships *Albatross IV* and *Delaware II*) were used to conduct NMFS surveys and a trawl door change occurred in 1985. Vessel and door conversion factors, derived from comparative fishing experiments (Forrester *et al.* 1997), were applied to the survey results to make the series consistent. Additionally, two different trawl nets were used on the NMFS spring surveys, a modified Yankee 41 from 1973 to 1981 and a Yankee 36 in all other years, but no conversion factors are available.

Starting in 2009, NMFS surveys were conducted by the NOAA ship *Henry B. Bigelow*, using a different net (3-bridle, 4 seam) and revised protocols. Given that the allocation is based on proportions of biomass distribution within a survey, the use of biomass-based conversion coefficients is not necessary, *i.e.* proportions would not change if survey indices were calibrated by a constant. As the conversion coefficients are length based, differences in fishing power between the vessels could potentially affect biomass estimates if there were large disparities in length composition on each side of the Hague Line. However, when length frequencies from the two jurisdictions were compared for the 2009 surveys, the differences were minor and application of a length-weight relationship to the length frequencies produced negligible differences in biomass.

The Canadian Coast Guard Ship (CCGS) *Alfred Needler* is the standard vessel used for the DFO Georges Bank survey, but, due to unavailability of the *Alfred Needler*, the CCGS *Wilfred Templeman*, a sister ship to the *Alfred Needler*, has been used in several years;

1993, 2004, 2007, and 2008. No conversion factors are available for the *Wilfred Templeman*. However, this vessel is considered to be similar in fishing strength to the *Alfred Needler*.

Swept area biomass, considered a relative index of abundance, was computed for each stratum and apportioned to USA and Canadian sectors in each year (see Figure 2 for strata and “strata sections” on each side of the international boundary, and Table 2 for their areas). DFO survey sampling strata were revised in 1987 to incorporate the international boundary. Thus, only results since 1987 have been used for this survey. Since the survey designs are based on randomization within strata, the data were post-stratified to USA and Canadian zones within the existing survey strata. Strata used for Atlantic Cod and Haddock also were divided by the management unit boundary.

Estimates of biomass indices were calculated for entire strata and for strata sections unless no observations occurred within a stratum (Tables 3 to 11). On the few occasions where no observations were available in a stratum section, density and distribution patterns from adjacent areas and years were used as substitute values. The magnitude of these derived values was generally small and did not influence results unduly. When such values are combined over surveys, they have only a minor effect on the annual aggregate biomass index estimates within the transboundary management units. The swept area biomasses for each groundfish species were summed individually to derive the biomass index on the USA and Canadian side for each management unit. Age and size specific distribution patterns were ignored while developing the biomass indices.

The biomass index estimate derived from each survey represents a synoptic snapshot of resource distribution at a specific time during a year. Combining the results of multiple surveys requires an understanding of seasonal movement patterns and how much of the biological year each survey represents. For Atlantic Cod, the DFO and the NMFS spring surveys in each year were averaged to characterize the distribution during the winter-spring period. This result was averaged with the NMFS fall distribution percentage, thereby giving equal weight to the winter-spring and summer-fall periods. Prior to initiation of the DFO survey in 1987, the NMFS spring survey was used alone to characterize the winter-spring period. For Haddock and Yellowtail Flounder, the results from all three surveys in each year were averaged to represent the annual distribution pattern. Prior to 1987, only the NMFS spring and fall surveys were averaged.

A robust locally weighted regression algorithm (Cleveland 1979), referred to as LOESS, was adopted for removing both unpredictable fluctuations and sampling variation from the survey observations. A 30% smoothing parameter was chosen as it reflected current trends, was responsive to changes, and provided the most appropriate results for contemporary resource sharing. The recommended default (Cleveland 1979) of two robustness iterations also was adopted. Resource distributions are updated annually by incorporating data from the latest surveys and dropping data from the earliest survey used in the previous year (2013 and 1980, respectively, in this case) so that a 33-year window is maintained. After the surveys were combined, the LOESS smoother was applied to the 1981 to 2013 survey data. The fixed resource utilization (10% weighting) and the 2013 resource distributions (90% weighting) were applied to the agreed sharing formula to determine national allocation shares of each of the three transboundary groundfish species for the fishing year two years beyond the latest survey data (2015).

Results

The country utilization aspect of the sharing formula, based on each country's landings during the period of 1967 to 1994 (Table 1), resulted in the following percentage weightings for utilization:

Stock	USA	CANADA
Eastern Georges Bank Atlantic Cod	40%	60%
Eastern Georges Bank Haddock	45%	55%
Georges Bank Yellowtail Flounder	98%	2%

The 2010 fishing year was the end of the transition to a 90/10 weighting of resource distribution and country utilization. Historical participation will now account for 10% of the sharing formula.

The three stocks' biomass indices were updated with 2013 values for the NMFS spring and fall surveys and the DFO survey (Tables 3 to 11; Figures 3, 4, and 5). For 2013 surveys, it was not necessary to derive any values for missing values. The biomass of Atlantic Cod in 2013 was highest on the Canadian side for all three surveys. This pattern is similar to 2011 and 2012, but it differed from 2010 when the DFO survey found very high biomass on the USA side and the NMFS spring survey detected approximately equal biomass on each side. Haddock biomass in 2013 was highest in USA waters for all surveys, particularly the NMFS fall and DFO surveys. This is in contrast to 2011 when Haddock biomass was highest in Canadian waters for all three surveys. For Yellowtail Flounder, biomass in 2013 was highest on the Canadian side for the NMFS spring and DFO surveys, and it was highest on the USA side for the NMFS fall survey. This is a change from 2012 when all three surveys found higher biomass in USA waters.

The resource distributions for the three surveys, for the combined surveys, and the results from the smoothing algorithm for the most recent 33-year time period, with the terminal year being 2013, were determined for Atlantic Cod, Haddock, and Yellowtail Flounder (Tables 12, 13, and 14, respectively; Figure 6). The smoothed percentages for 2013 differ from those previously presented (Murawski and Gavaris 2004; Stone *et al.* 2013), due to dropping the earliest year of survey data and the incorporation of the next recent year of survey data in the smoothing algorithm. The resulting smoothed resource distributions for eastern Georges Bank in 2013 were, for cod: 83% Canada, 17% USA; for Haddock: 52% Canada, 48% USA; and for Yellowtail Flounder: 33% Canada, 67% USA (Figure 6).

The 2013 resource distributions, after smoothing, and the fixed resource utilization were applied to the agreed sharing formula and result in shares for the 2015 fishing year (calendar year for Canada; May 1, 2015 to April 30, 2016 for the USA) for Atlantic Cod of 81% Canada, 19% USA; for Haddock of 52% Canada, 48% USA; and for Yellowtail Flounder of 30% Canada, 70% USA (Table 15).

The abundance of Atlantic Cod declined in the mid 1980s and the biomass index in USA waters declined markedly, particularly in the NMFS fall survey (Figure 3). Most of the Atlantic Cod biomass during the NMFS spring surveys (Table 3) and the DFO surveys

(Table 5) was located on the top of Georges Bank in shallower depths (in DFO survey stratum 5Z2 and NMFS survey strata 16, 19, and 20, although, 19 and 20 were more important in the 1970s and early 1980s and have now declined in importance). The deeper slope strata have always been more important for Atlantic Cod in the NMFS fall survey than in the spring surveys (Table 4), but, after the late 1980s, these strata (particularly the deeper water on the Canadian side of NMFS survey strata 21 and 17, with high variability for stratum 17) became even more important as biomass shifted away from the top of the Bank (shift is also evident for the 2013 DFO survey where much of the cod biomass is in stratum 5Z1). Exceptions occurred in the 2011 and 2013 NMFS fall surveys when most of the cod occurred in Canadian waters on top of the bank (stratum 16). The percentage of Atlantic Cod in Canadian waters during the NMFS spring and DFO surveys generally has been lower than the percentage during the NMFS fall surveys although there have been a few exceptions in recent years. This difference has become more pronounced since the mid 1980s (Table 12, Figure 3).

Haddock abundance is near historic highs. It peaked during the early 1960s and again in the late 1970s, increased during the late 1990s, and rose to very high levels in the 2000s (Figure 4). The biomass index in USA waters was exceptionally high during the 1960s, and, coincident with the increase in Haddock abundance in recent years, the percentage in USA waters in the NMFS surveys, especially in the spring, has increased. As with Atlantic Cod, Haddock biomass is concentrated on top of the Bank during both the NMFS spring and DFO surveys (Tables 6 and 8). However, in the 2013 there were also significant increases in biomass in the deeper strata, 19 and 5Z1 and 5Z3 for the NMFS spring and DFO surveys, respectively. Since the 1970s, Haddock biomass in the fall NMFS surveys has been concentrated in the deeper slope strata in Canadian waters. Stratum 19, entirely in USA waters, was important only in the early part of the fall series (Table 7). However, in 2013 it contained approximately 17% of the biomass estimate. The percentage of Haddock on each side of the Canada/USA boundary from the DFO survey is generally somewhat intermediate between the NMFS fall and NMFS spring survey results but reached 100% in Canadian waters in 2009 (Table 13, Figure 4). For the first time, the percentage of Haddock was higher in USA waters for the NMFS fall survey (70%, Table 13).

Yellowtail Flounder survey abundance is approaching historic lows. It was high in the 1960s, declined and remained low during the 1970s and 1980s, increased during the 1990s, declined again, and then increased to 1960's levels in 2009 (Figure 5). The biomass index in USA waters was highest during the 1960s. In all three survey series (Tables 9 to 11), Yellowtail Flounder biomass has been highest on the southern flank of the Bank at the shallower depths in NMFS survey strata 13 and 16 and in DFO survey strata 5Z2 and 5Z4. NMFS survey stratum 19, a shallow depth stratum near the middle of the bank, was important during the 1960s only. A change in distribution occurred in 2008 and 2009, during the DFO survey, due to large catches in Canadian waters and the substantial decrease in catches on the USA side in those years. While the large yellowtail catches in 2008 and 2009 had an appreciable influence on the overall abundance index for the stock (Table 11, Figure 5), their impact on the estimated biomass distribution was less (Van Eckhaute and O'Brien 2010). Averaging the 2008 and 2009 DFO surveys with the NMFS spring and fall surveys and subjecting the result to the smoothing algorithm produced no change in the Yellowtail Flounder allocation, whether the large tows were included or not. Such fluctuations have been observed in the past and the averaging/smoothing algorithm

appears to handle them adequately (Figure 6). In 2011 and 2012, the distribution of yellowtail from the DFO survey shifted from Canadian (strata 5Z1/5Z2) to USA waters (strata 5Z4), whereas in 2013 more biomass was detected in Canadian strata (Table 11).

The percentage of biomass of eastern Georges Bank cod in Canadian waters, as indicated by the combined smoothed results, progressively increased from about 60% in the late 1970s to approximately 80% in the late 1980s, fluctuated between 83% and 85% until 2003, declined to 77% in 2006, and then increased again to 87% in 2011 (Table 12, Figure 6). In 2013 the percentage in Canadian waters was 83%. The percentage of biomass of eastern Georges Bank Haddock in Canadian waters fluctuated around 80% from the late 1970s and 1980s to almost 90% in the mid 1990s, and, with the large increase in biomass, has subsequently declined to 53% in 2013 (Table 13, Figure 6). The percentage of Georges Bank Yellowtail Flounder biomass in Canadian waters was at a low of 18% in 1979, gradually increased through the 1980s and most of the 1990s to about 50%, declined to 35% in 2005/2006, and then increased to 63% in 2011 (Table 14, Figure 6). In 2012, the percentage of Yellowtail Flounder biomass in Canadian waters dropped sharply to 20%, and in 2013 it was 32%.

Discussion

Consistent fisheries management advice utilizing the allocation sharing arrangement was provided for the first time in the 2003 TMGC Guidance Document (TMGC 2003) for application to the 2004 fishing year quotas and subsequently in the 2004 to 2013 TMGC Guidance Documents for application to the 2005 to 2014 fishing year quotas, respectively (TMGC 2013). However, in 2009, due to the inability of TMGC to come to an agreement on the Yellowtail Flounder quota, the Yellowtail Flounder allocation sharing arrangement for 2010 was not adhered to. The enactment of the International Fisheries Agreement Clarification Act by the USA in January 2011, which allows the USA more flexibility in negotiating quotas in TMCG, should facilitate adherence to the sharing arrangement. It is recognized that the analyses are based on calendar year data but that the fishing year for USA fisheries starts May 1 and ends April 30. The fishing year for Canadian fisheries starts January 1 and ends December 31.

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Table 1. Annual landings (mt) of Atlantic Cod, Haddock, and Yellowtail Flounder from the transboundary management units on Georges Bank.

Year	Atlantic Cod			Haddock			Yellowtail Flounder		
	Canada	USA	Total	Canada	USA	Total	Canada	USA	Total
1967	8188	3115	11303	12999	11999	24998	133	8407	8540
1968	9055	3244	12299	9195	7646	16841	122	12799	12921
1969	5876	3676	9552	3941	6621	10562	327	15944	16271
1970	2580	3211	5791	1970	3154	5124	70	15505	15575
1971	2950	4389	7339	1610	3533	5143	102	11878	11980
1972	2535	2708	5243	609	1551	2160	8	14157	14165
1973	3222	3064	6286	1565	1396	2961	12	15899	15911
1974	1370	3792	5162	462	955	1417	5	14607	14612
1975	1833	3108	4941	1353	1705	3058	8	13205	13213
1976	2320	2037	4357	1362	974	2336	11	11336	11347
1977	6156	4256	10412	2871	2428	5299	38	9444	9482
1978	8777	5502	14279	9968	4724	14692	56	4519	4575
1979	5979	6408	12387	5080	5212	10292	17	5475	5492
1980	8065	6418	14483	10017	5615	15632	81	6481	6562
1981	8498	8092	16590	5658	9075	14733	12	6182	6194
1982	17825	8565	26390	4872	6280	11152	18	10634	10652
1983	12131	8573	20704	3208	4453	7661	43	11350	11393
1984	5761	10551	16312	1463	5120	6583	4	5764	5768
1985	10442	6641	17083	3484	1684	5168	3	2477	2480
1986	8411	5697	14108	3415	2201	5616	27	3041	3068
1987	11844	4793	16637	4703	1418	6121	56	2743	2799
1988	12740	7645	20385	5941	1694	7635	47	1866	1913
1989	7895	6182	14077	3060	785	3845	32	1134	1166
1990	14364	6414	20778	3340	1188	4528	13	2751	2764
1991	13459	6353	19812	5423	931	6354	25	1784	1809
1992	11673	5080	16753	4090	1629	5719	15	2859	2874
1993	8524	4027	12551	3725	424	4149	675	2089	2764
1994	5278	1229	6507	2412	32	2444	2139	1589	3728
1995	1099	638	1737	2062	22	2084	470	410	880
1996	1921	757	2678	3666	35	3701	472	777	1249
1997	2919	551	3470	2749	47	2796	809	969	1778
1998	1893	828	2721	3362	311	3673	1175	1836	3011
1999	1818	1151	2969	3679	355	4034	1992	2066	4058
2000	1572	662	2234	5402	188	5590	2860	3678	6538
Total 1967-94	217751	144770	362521	117796	94427	212223	4099	215919	220018
Percentage 1967-94	60%	40%	-	56%	45%	-	2%	98%	-

Table 2. Strata (or strata section) areas (in square nautical miles) used in the calculation of biomass indices. The designation ‘eGB’ denotes the eastern Georges Bank management unit used for cod and Haddock. The designation ‘~eGB’ denotes the portion of the stratum not in the eastern Georges Bank management unit.

DFO/NMFS Strata	Canada	USA(eGB)	USA(~eGB)
DFO 5Z1	795	0	0
5Z2	1252	0	0
5Z3	0	1504	791
5Z4	0	1350	1729
NMFS 13	0	0	2374
14	0	0	656
15	0	0	230
16	1553	1427	0
17	284	76	0
18	127	45	0
19	0	1059	1395
20	0	335	886
21	210	78	136
22	125	106	223

Table 3. Atlantic Cod biomass (mt) index by strata sections of eastern Georges Bank (see Figure 2) from the NMFS spring survey. Shaded cells represent missing values calculated from adjacent strata sections. Cells with “-” represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1968	1543	2053	-	313	-	16	2762	0	335	70	0	-	4640	2451
1969	1876	4015	0	264	0	0	2413	2882	452	0	-	0	7623	4278
1970	948	4877	0	375	0	28	520	809	164	0	-	0	2441	5280
1971	3071	4267	0	258	0	0	2376	383	0	365	-	0	5830	4890
1972	1322	5875	0	69	0	0	3749	1378	68	669	-	32	6518	6645
1973	16082	13420	-	136	0	195	6119	47331	275	1004	405	279	70212	15035
1974	8700	13169	0	230	-	32	2681	260	92	872	0	68	11733	14370
1975	2515	3220	0	370	-	12	6365	20482	20	287	-	119	29382	4008
1976	2017	2302	-	567	-	5	4949	5985	81	527	0	-	13032	3402
1977	694	2118	0	218	0	0	2073	1872	227	2055	100	0	4966	4391
1978	3959	6849	25	627	0	9	2584	407	-	2262	155	2627	7129	12375
1979	2044	5988	0	405	-	94	436	751	711	1357	206	42	4148	7885
1980	6542	10355	83	460	-	123	995	981	152	655	112	212	8865	11805
1981	4839	1927	103	894	-	-	2235	3654	489	821	72	1495	11391	5137
1982	476	123809	27	146	222	286	460	2591	-	483	196	993	3972	125717
1983	549	7246	246	784	0	93	0	8737	619	588	106	253	10258	8963
1984	1532	1527	78	239	0	0	793	4797	0	250	301	223	7500	2240
1985	1142	9618	29	57	0	159	2886	3032	-	1239	-	675	7088	11747
1986	1504	5622	103	45	0	13	2824	298	23	1712	-	425	4751	7817
1987	1430	3370	0	497	0	23	549	804	74	305	-	250	2856	4444
1988	1236	4560	0	334	-	42	1403	243	60	1229	0	269	2942	6432
1989	583	4630	0	33	-	9	1875	550	0	250	-	0	3008	4923
1990	1128	4693	0	519	-	146	475	449	57	108	-	603	2110	6068
1991	559	3512	-	178	-	157	1920	154	115	617	-	36	2748	4499
1992	0	2116	-	293	-	9	491	316	55	639	-	1240	862	4296
1993	749	695	-	1322	-	0	2229	472	-	134	-	229	3451	2380
1994	143	0	0	21	0	-	96	43	36	658	-	73	318	752
1995	350	7548	-	63	0	-	302	503	-	265	-	150	1154	8026
1996	1161	1545	-	221	-	0	1211	74	358	1653	0	0	2803	3419
1997	756	1561	11	107	0	28	471	0	116	176	-	343	1355	2214
1998	235	6238	0	187	-	72	0	-	110	5408	186	263	531	12168
1999	1053	2482	0	13	-	0	337	667	0	338	495	25	2552	2858
2000	1458	3281	0	11	0	-	967	1513	27	302	-	96	3965	3691
2001	191	1795	-	59	-	0	275	166	207	155	-	340	839	2349
2002	1341	2243	0	23	-	46	318	-	0	477	0	64	1659	2851
2003	478	3194	25	50	-	0	387	61	242	318	149	131	1342	3694
2004	309	2252	-	12	-	119	252	2462	119	11393	-	0	3142	13776
2005	1235	1599	0	266	0	-	0	64	-	697	121	151	1420	2713
2006	3162	511	0	457	-	0	524	277	509	1011	-	0	4472	1979
2007	2287	1759	15	128	0	0	398	237	452	260	-	82	3388	2229
2008	1488	1669	0	18	0	0	368	300	6	788	0	345	2162	2820
2009	1024	2673	7	0	0	100	535	47	256	3045	37	0	1906	5817
2010	541	1070	0	410	0	125	667	461	941	1010	94	198	2704	2813
2011	474	1573	0	133	0	74	56	0	0	460	0	196	530	2436
2012	1075	3504	6	182	0	0	646	1412	0	695	0	146	3139	4528
2013	701	1211	0	0	0	77	740	1312	0	7808	61	239	2814	9335

Table 4. Atlantic Cod biomass (mt) index by strata sections of eastern Georges Bank (see Figure 2) from the NMFS fall survey. Shaded cells represent missing values calculated from adjacent strata sections. Cells with “-” represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1963	385	6654	0	0	0	-	3851	2806	245	2313	0	-	7287	8968
1964	0	5453	0	230	0	0	1089	750	-	1180	-	0	1840	6864
1965	0	1328	-	32	0	42	0	125	143	386	27	322	295	2110
1966	0	1414	0	68	0	779	386	467	6	480	0	280	859	3021
1967	1799	1421	0	1661	0	228	2876	1908	98	386	-	96	6682	3793
1968	0	226	0	445	-	134	515	640	81	432	-	849	1236	2087
1969	23	495	0	104	-	37	309	516	45	316	0	772	893	1723
1970	0	461	0	0	-	249	1445	1718	143	679	-	286	3306	1674
1971	19	1439	0	744	0	0	1089	2165	11	131	-	0	3285	2314
1972	815	2016	-	314	0	0	0	0	138	310	0	-	953	2639
1973	54	3215	0	572	0	149	1944	5096	33	949	-	-	7128	4886
1974	0	601	0	0	0	46	0	1227	0	2160	0	0	1227	2807
1975	0	2742	-	323	0	182	0	1094	18	255	0	10	1112	3513
1976	79	3547	0	21	0	36	51	1150	87	1148	0	71	1367	4824
1977	165	1770	0	475	0	322	602	2963	423	1353	253	129	4407	4050
1978	0	4898	0	345	0	213	1684	303	1105	744	242	557	3333	6756
1979	1084	7191	0	225	-	747	914	1141	157	754	40	40	3336	8957
1980	0	784	0	1049	0	34	529	805	11	536	39	182	1385	2585
1981	65	3498	31	1156	0	36	713	588	80	701	18	41	1495	5431
1982	0	382	-	250	-	0	0	491	11	655	146	0	648	1286
1983	0	352	-	74	0	36	0	255	15	1289	18	-	288	1751
1984	0	3745	-	495	0	838	0	244	-	345	0	-	244	5423
1985	0	1926	-	189	0	85	0	1	9	98	-	16	10	2313
1986	138	722	-	217	0	102	0	0	710	147	0	0	848	1187
1987	0	1359	-	52	-	260	0	0	166	294	51	41	217	2006
1988	0	2154	-	251	-	610	2	6	-	385	30	1400	38	4799
1989	0	2329	-	216	0	-	0	7	3	893	23	13	33	3451
1990	12	2647	0	285	-	27	0	0	-	1014	-	16	12	3989
1991	0	118	-	109	0	-	-	0	0	88	0	7	0	322
1992	57	643	0	704	-	0	0	35	13	380	-	57	105	1784
1993	0	92	-	188	-	0	0	0	-	54	-	26	0	361
1994	0	56	-	157	-	201	0	0	7	1583	-	0	7	1997
1995	0	23	-	127	-	71	0	67	28	1171	0	-	95	1392
1996	0	652	-	311	-	48	0	-	66	181	-	93	66	1284
1997	0	0	-	57	-	0	0	0	-	1285	-	0	0	1342
1998	0	1031	-	31	-	170	0	0	-	769	-	-	0	2001
1999	0	58	-	154	-	56	0	0	-	465	22	15	22	748
2000	0	269	-	226	-	48	0	0	0	234	0	0	0	778

Table 4. continued.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
2001	40	423	-	431	-	0	0	0	0	288	-	9	40	1151
2002	0	2955	0	366	-	34	207	0	0	7312	61	16	268	10684
2003	0	133	-	0	-	0	135	0	0	405	-	23	135	561
2004	0	5982	0	485	0	50	0	0	41	731	61	0	102	7247
2005	0	486	0	445	0	40	0	77	32	366	0	102	109	1440
2006	59	1781	0	0	0	0	0	-	-	190	-	0	59	1972
2007	0	149	0	34	-	0	47	47	4	214	-	21	98	418
2008	0	368	0	131	0	73	0	0	0	108	0	23	0	704
2009	0	834	0	16	0	0	0	332	0	724	24	31	356	1605
2010	0	457	0	0	0	47	0	0	0	480	45	0	45	984
2011	0	3317	0	77	0	160	0	0	112	93	0	0	112	3647
2012	0	120	0	0	0	0	0	0	0	622	171	0	171	741
2013	0	2745	0	110	0	25	25	98	0	551	0	0	123	3431

Table 5. Atlantic Cod biomass (mt) index by strata and strata sections of eastern Georges Bank (see Figure 2) from the DFO survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1987	1555	5826	1345	98	1443	7381
1988	1894	12927	3856	775	4631	14821
1989	2040	8664	2766	1076	3842	10704
1990	1708	48900	4622	1435	6057	50608
1991	2204	17398	3820	1646	5467	19601
1992	2087	7602	4005	887	4892	9689
1993	719	9427	3875	2524	6399	10146
1994	817	11821	455	47	502	12638
1995	919	3277	3368	553	3921	4197
1996	1090	22489	3927	4667	8594	23579
1997	377	7336	2095	1196	3290	7714
1998	332	4091	551	32	583	4423
1999	211	6880	1206	880	2086	7092
2000	228	21947	9281	842	10123	22174
2001	1499	15563	257	718	975	17062
2002	2298	17043	309	683	992	19341
2003	720	3571	1130	797	1927	4291
2004	685	4248	699	29	728	4933
2005	1597	7306	192	17105	17298	8903
2006	127	8469	2652	1299	3951	8595
2007	836	8930	911	552	1462	9766
2008	5880	6603	327	848	1175	12483
2009	2195	20917	0 ¹	54	54	23113
2010	218	8694	16963	477	17440	8913
2011	3702	4031	543	161	704	7733
2012	444	1311	504	203	708	1755
2013	7079	1538	1819	677	2496	8617

¹No cod were caught in 7 tows in this stratum section.

Table 6. Haddock biomass (mt) index by strata sections of eastern Georges Bank (see Figure 2) from the NMFS spring survey. Shaded cells represent missing values calculated from adjacent strata sections. Cells with “-“ represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1968	4767	5197	-	856	-	84	4637	1012	-	29	226	203	10642	6367
1969	11660	2342	0	1141	0	0	1914	71	0	44	152	137	13797	3664
1970	36753	2583	0	448	0	0	1381	120	201	73	18	159	38474	3263
1971	1102	469	0	194	3	0	1215	0	240	38	-	1097	2561	1798
1972	1017	3843	0	20	0	0	856	0	278	393	-	0	2151	4256
1973	2320	5270	-	113	0	0	1546	207	42	86	0	1284	4116	6752
1974	718	13765	0	77	-	6	4334	0	-	194	0	-	5052	14042
1975	4047	7002	0	59	-	0	1203	0	24	8076	-	34	5273	15171
1976	1955	1802	-	229	-	0	1003	-	2	856	0	-	2961	2887
1977	323	3283	0	43	0	0	1165	1242	41	13720	0	0	2771	17046
1978	6884	11740	6	56	0	24	2520	0	121	9148	-	151	9531	21119
1979	3715	12218	10	84	-	0	1049	0	103	987	260	2005	5137	15294
1980	21009	6764	13	263	-	67	26933	-	0	18795	82	96	48036	25985
1981	12286	15870	2	44	-	-	9096	3890	-	4215	370	944	25642	21073
1982	3830	8719	131	348	0	11	1200	859	-	2342	91	1029	6112	12450
1983	1487	5525	21	668	0	0	0	708	61	3999	464	368	2741	10559
1984	3539	4784	8	168	0	0	1497	-	2	154	120	170	5166	5276
1985	1793	8819	14	99	0	18	167	0	-	3696	-	54	1974	12686
1986	1210	6880	0	21	0	0	367	0	0	1297	-	0	1578	8197
1987	245	7607	0	101	0	17	0	1005	-	63	-	69	1250	7856
1988	3085	2097	0	13	-	0	169	0	0	310	0	0	3255	2419
1989	5778	2961	28	146	-	79	123	0	0	751	-	256	5929	4193
1990	1612	8848	0	64	-	-	0	0	33	1305	-	21	1645	10238
1991	1012	6001	-	37	-	0	0	0	0	28	-	0	1012	6067
1992	442	1530	-	80	-	0	93	0	-	376	-	0	536	1986
1993	266	3234	-	439	-	0	0	0	-	387	-	154	266	4214
1994	2	801	11	1	0	-	0	-	6	5644	-	0	19	6446
1995	2297	578	42	60	0	-	778	0	2	3356	-	888	3119	4881
1996	3720	1021	23	32	-	0	8581	0	8	972	31	0	12362	2026
1997	218	1884	10	28	0	11	0	0	45	1239	-	74	273	3237
1998	574	6600	3	84	-	5	0	-	282	227	0	108	859	7024
1999	6267	3485	0	1598	-	0	0	74	42	366	37	38	6420	5487
2000	4238	3712	0	220	0	-	198	668	522	151	-	55	5626	4138
2001	297	1537	-	446	-	0	71	0	1215	4339	-	15	1583	6337
2002	13973	9781	0	332	-	15	8094	-	0	897	93	78	22161	11103
2003	2149	14472	2	77	-	0	699	291	1123	1438	19	46	4282	16034
2004	25198	27752	-	978	-	75	3503	28736	715	669	-	3	58152	29477
2005	1575	3031	680	948	0	-	4991	144	-	3945	132	484	7522	8408
2006	11166	8302	5	323	-	97	758	3059	143	4140	-	40	15131	12901
2007	9617	23430	7	64	0	90	19906	12979	295	795	-	124	42804	24502
2008	40456	5465	2	135	0	164	87	1869	484	151	0	204	42898	6120
2009	22760	4635	88	245	0	37	1061	1502	6546	6224	0	19	31957	11159
2010	11191	11361	92	85	0	147	12458	2895	1364	2968	36	109	28037	14670
2011	5332	6871	17	859	0	157	515	0	364	2642	0	740	6228	11270
2012	28213	15155	15	2039	1	315	3285	2483	0	3635	0	101	33996	21245
2013	24543	14231	0	557	0	294	5952	5047	0	18415	123	326	35664	33823

Table 7. Haddock biomass (mt) index by strata sections of eastern Georges Bank (see Figure 2) from the NMFS fall survey. Shaded cells represent missing values calculated from adjacent strata sections. Cells with “-” represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
1963	12153	8911	0	1892	0	2127	27496	1401	541	2689	240	194	41832	15814
1964	26324	5986	227	851	0	957	25601	9150	1531	2158	442	34	63275	9986
1965	6109	8981	-	773	0	687	16273	2064	112	2492	498	1114	25056	14047
1966	2640	8170	26	142	0	287	11825	1985	6	308	618	210	17100	9115
1967	1372	1700	0	448	22	304	2377	425	1884	193	-	360	6080	3005
1968	0	8032	0	129	-	377	0	71	21	0	-	651	92	9188
1969	599	0	0	146	-	0	1107	1927	-	86	0	102	3633	333
1970	27	743	8	555	-	542	9156	0	32	1035	-	274	9223	3149
1971	244	361	0	356	0	57	2463	0	112	29	-	470	2819	1272
1972	151	1143	-	685	0	43	0	0	0	0	72	204	223	2076
1973	83	9296	0	811	0	26	0	0	-	36	-	-	83	10169
1974	0	586	0	99	0	35	0	-	0	560	341	0	341	1279
1975	560	747	-	1322	0	226	0	425	-	0	37	540	1022	2835
1976	0	44340	0	375	0	307	0	-	-	9637	152	724	152	55381
1977	4	2886	0	623	0	510	88	0	482	24478	253	3131	827	31628
1978	133	1848	0	6727	0	1074	475	9	0	872	120	490	737	11010
1979	2561	2193	5	143	-	871	0	2	-	730	575	3233	3143	7171
1980	5	1228	0	4167	0	394	647	44	228	363	51	850	974	7002
1981	647	4886	213	2349	0	348	5	20	266	570	316	552	1467	8705
1982	162	1919	-	2889	-	1423	0	0	26	60	128	14	316	6305
1983	95	334	-	1061	0	506	0	0	-	197	262	333	357	2431
1984	0	308	-	1603	0	455	0	0	-	71	152	194	152	2632
1985	497	590	-	739	0	395	0	0	7	453	-	18	504	2195
1986	0	2368	-	1383	0	465	0	0	16	2079	0	26	16	6321
1987	7	8	-	320	-	140	8	7	0	205	0	239	22	911
1988	50	1134	-	366	-	1588	0	0	-	1724	0	413	50	5224
1989	4	528	-	987	2	1114	0	8	6	1331	46	296	66	4257
1990	51	29	0	1396	-	401	0	0	-	885	-	132	51	2842
1991	20	92	-	561	0	0	-	0	8	0	0	178	28	831
1992	171	292	0	585	-	173	0	8	0	6	-	21	179	1077
1993	0	443	-	217	-	0	0	0	-	4103	-	83	0	4846
1994	0	0	-	284	-	347	0	0	0	1162	-	0	0	1793
1995	4	5214	-	843	-	1373	0	0	0	6575	0	-	4	14005
1996	10	2057	-	1138	-	639	0	-	1	179	-	0	10	4012
1997	0	4	-	133	-	0	2	5	8	6012	-	0	15	6149
1998	7	3409	-	285	-	471	0	37	7	2241	-	-	51	6406
1999	0	151	-	113	-	2021	0	0	-	13900	0	0	0	16184
2000	100	1646	-	365	-	1351	0	0	0	9432	0	0	100	12795

Table 7. continued.

Year	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA 22	CAN 22	USA total	CAN total
2001	1013	1471	-	2264	-	395	0	0	0	21540	-	491	1013	26161
2002	314	21420	8	591	-	201	0	144	0	19620	206	223	671	42054
2003	2736	3312	-	331	-	95	342	219	123	6453	-	0	3420	10191
2004	3275	24845	746	1115	0	693	0	5	1766	8248	223	1181	6014	36083
2005	5647	13381	2	1071	0	98	3	120	585	5617	2650	11761	9009	31927
2006	2088	20548	0	837	0	571	0	-	-	4502	-	7275	2088	33732
2007	203	2560	6	788	-	39	0	0	11208	2860	-	15315	11417	21561
2008	89	2578	2	4246	0	775	0	0	0	8005	0	7470	91	23074
2009	11958	14743	0	2070	0	0	12254	304	240	3999	188	36	24944	20848
2010	2936	14967	50	1554	1	1087	0	0	2677	2604	697	707	6361	20919
2011	9122	29552	1606	2549	1	2355	166	0	1178	1096	0	443	12073	35995
2012	564	21464	0	798	0	0	0	0	784	29443	736	7528	2083	59233
2013	61804	27768	676	1060	89	894	22938	6321	0	3769	0	7276	91829	40766

Table 8. Haddock biomass (mt) index by strata and strata sections of eastern Georges Bank (see Figure 2) from the DFO survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1987	2661	12956	375	99	475	15617
1988	1350	16559	8305	96	8401	17909
1989	982	9377	641	198	839	10359
1990	3943	15963	3424	4155	7579	19907
1991	3084	13597	7383	3260	10643	16680
1992	3544	10403	5953	576	6530	13946
1993	2064	2367	110	2411	2521	4432
1994	8871	9968	19	90	108	18839
1995	2244	18041	336	0	336	20285
1996	4947	16985	440	839	1279	21933
1997	1853	11022	1298	179	1476	12875
1998	15844	29323	89	11	99	45167
1999	14775	15221	506	319	825	29996
2000	4682	41522	11048	158	11206	46205
2001	9471	43754	2022	513	2535	53225
2002	5695	28569	3391	11863	15254	34264
2003	1583	89462	4334	27407	31741	91045
2004	21198	71574	5479	1796	7274	92772
2005	9638	39589	1931	5209	7140	49226
2006	5445	53525	35052	6285	41337	58970
2007	9705	43079	3811	5009	8820	52784
2008	35446	47657	34798	6063	40861	83102
2009	29750	41728	0 ¹	82	82	71478
2010	1137	44993	5148	19991	25139	46130
2011	12095	32436	4114	10518	14632	44530
2012	4365	29550	25010	18497	43508	33915
2013	21809	50425	60218	31062	91281	72235

¹No Haddock were caught in 7 tows in this stratum section.

Table 9. Yellowtail Flounder biomass (mt) index by strata and strata sections of Georges Bank (see Figure 2) from the NMFS spring survey. Cells with “-” represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 13	USA 14	USA 15	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA total	CAN total
1968	326	0	0	1228	413	-	0	-	0	1052	99	0	0	2705	413
1969	2239	0	0	1524	633	22	0	0	0	7425	107	100	0	11416	633
1970	2975	0	0	773	156	29	0	0	0	1359	653	17	0	5806	156
1971	2114	29	0	1146	183	0	0	0	0	1284	0	49	0	4622	183
1972	2056	10	0	1505	1307	0	0	0	0	1979	214	0	0	5764	1307
1973	1204	6	0	862	611	-	5	0	0	367	83	5	317	2528	932
1974	782	0	0	623	522	0	0	-	0	870	214	0	0	2488	522
1975	258	17	0	344	781	0	0	-	0	349	89	0	-	1057	781
1976	835	0	0	375	674	-	6	-	0	430	107	2	0	1748	680
1977	152	7	0	124	666	0	0	0	0	30	20	0	37	332	703
1978	224	7	0	119	180	0	3	0	0	159	90	7	0	607	182
1979	312	0	0	193	422	5	9	-	0	315	20	5	0	849	432
1980	933	0	0	387	2300	0	131	-	2	389	81	2	4	1793	2437
1981	211	9	0	1035	137	0	25	-	-	185	19	0	73	1459	235
1982	1202	0	3	175	563	0	10	0	4	694	0	10	0	2084	578
1983	355	13	0	431	799	0	73	0	3	1023	161	16	-	1999	875
1984	135	0	0	342	747	-	0	0	0	265	201	16	0	960	747
1985	127	0	0	200	473	0	0	0	3	131	55	0	0	512	475
1986	190	0	0	68	584	0	0	0	0	71	0	9	20	338	604
1987	66	0	0	114	102	0	0	0	0	71	0	2	0	253	102
1988	193	0	0	183	146	0	0	-	0	46	6	40	0	467	146
1989	179	0	0	115	322	0	0	-	0	65	2	2	3	363	324
1990	545	0	0	30	117	0	7	-	-	37	0	0	0	612	124
1991	233	0	0	139	286	-	0	-	0	7	0	0	0	380	286
1992	295	0	0	178	1200	-	9	-	0	169	45	0	25	688	1233
1993	84	0	0	83	349	-	8	-	0	49	0	0	6	217	363
1994	103	0	0	127	383	0	0	0	-	70	0	55	37	356	419
1995	298	0	0	439	1854	-	0	0	-	41	12	4	44	794	1898
1996	103	0	0	1020	1724	-	9	-	0	229	120	13	23	1485	1756
1997	95	0	0	432	3631	0	0	3	0	35	59	2	0	626	3631
1998	704	0	0	910	676	0	0	-	0	38	65	19	302	1737	978
1999	768	0	0	2571	6830	0	0	-	0	5	67	36	3	3448	6833
2000	681	0	0	2003	4927	0	6	0	-	180	33	61	0	2956	4933
2001	61	0	0	2486	2389	-	8	-	0	101	20	240	17	2908	2413
2002	66	0	0	3656	3876	0	0	-	0	663	8	4	3150	4397	7026
2003	173	0	0	895	6384	0	28	-	0	21	0	14	-	1103	6412
2004	261	0	-	535	1219	-	0	-	0	74	16	0	62	886	1281
2005	216	0	0	2094	1025	0	0	0	-	44	0	0	33	2354	1058
2006	93	5	0	1258	1051	0	0	-	0	87	58	2	2	1504	1053
2007	372	382	3	733	3271	0	6	0	0	38	81	89	0	1699	3277
2008	234	0	0	968	1241	44	969	0	0	92	22	28	29	1388	2238
2009	1338	0	0	4298	5566	61	116	0	0	380	24	69	104	6171	5786
2010	573	974	0	4059	6352	0	6	1	0	2491	80	3	39	8182	6397
2011	3238	110	0	1821	251	7	0	0	0	368	89	6	0	5640	251
2012	1637	0	0	4763	817	0	7	0	1	1098	424	14	111	7937	936
2013	129	0	0	752	1219	6	28	0	0	0	64	6	175	957	1421

Table 10. Yellowtail Flounder biomass (mt) index by strata and strata sections of Georges Bank (see Figure 2) from the NMFS fall survey. Cells with “-“ represent missing values assumed to be zero while “0” represents observed zeros.

Year	USA 13	USA 14	USA 15	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA total	CAN total
1963	6254	153	15	1741	477	84	41	5	-	2136	3102	13	0	13502	518
1964	10125	60	0	1102	114	26	33	0	0	3324	113	0	7	14751	154
1965	6677	24	0	247	80	-	17	0	0	1451	1419	62	0	9879	97
1966	669	0	0	164	1336	5	5	0	0	1351	353	25	4	2566	1345
1967	1622	10	23	2359	0	119	0	0	0	2202	495	0	0	6830	0
1968	2864	0	0	2143	1491	9	0	-	0	4178	323	5	0	9521	1491
1969	2927	0	0	1859	298	86	0	-	0	3738	156	7	0	8773	298
1970	1519	0	0	632	424	75	0	-	0	2206	318	62	0	4812	424
1971	3359	19	9	1766	179	0	0	3	4	1222	0	137	0	6514	183
1972	4504	29	0	1827	306	-	0	0	0	339	0	232	0	6930	306
1973	1867	0	0	2225	2377	5	0	0	0	178	13	349	36	4638	2414
1974	2286	0	0	749	825	0	0	0	0	126	0	0	0	3160	825
1975	770	19	0	936	747	-	0	0	0	80	36	0	0	1842	747
1976	128	0	0	1070	167	0	75	0	0	17	63	55	34	1333	276
1977	139	123	0	712	1765	0	7	0	-	109	91	60	0	1235	1772
1978	1129	0	0	838	336	0	78	0	0	151	31	1	0	2151	414
1979	479	0	0	739	156	0	5	-	0	9	45	48	4	1320	165
1980	40	14	0	1975	3869	8	26	0	0	970	93	110	173	3211	4068
1981	941	0	0	1250	106	0	0	0	0	190	0	22	0	2403	106
1982	1512	0	0	110	603	-	0	-	0	105	23	42	0	1792	603
1983	753	0	0	731	676	-	0	0	0	0	0	141	0	1625	676
1984	304	0	0	201	85	-	5	0	0	31	0	45	17	581	108
1985	141	0	0	405	171	-	4	0	0	0	0	0	38	547	212
1986	208	0	0	438	155	-	0	0	0	8	2	4	0	659	155
1987	69	0	0	193	267	-	0	-	0	16	0	0	0	278	267
1988	18	0	0	121	60	-	0	-	0	0	4	0	13	144	73
1989	794	0	0	202	83	-	0	0	-	9	21	0	0	1026	83
1990	388	0	0	282	76	0	0	-	0	32	0	0	0	702	76
1991	90	0	0	661	99	-	0	3	-	0	0	25	0	779	99
1992	177	0	0	9	419	0	0	-	0	16	22	0	0	224	419
1993	47	0	0	24	327	-	12	-	0	0	7	18	0	96	339
1994	113	0	0	105	755	-	18	-	0	11	0	118	19	347	792
1995	47	0	0	80	214	-	0	-	0	3	10	71	0	211	214
1996	90	0	0	1494	284	-	0	-	0	0	0	10	0	1593	284
1997	232	0	0	1808	1999	-	0	-	0	38	0	37	3	2115	2003
1998	818	0	0	592	2364	-	3	-	0	0	20	5	0	1435	2367
1999	770	0	0	2935	3962	-	191	-	0	224	114	157	0	4200	4154
2000	171	0	0	5580	1097	-	4	-	0	60	22	144	20	5978	1121

Table 10. continued.

Year	USA 13	USA 14	USA 15	USA 16	CAN 16	USA 17	CAN 17	USA 18	CAN 18	USA 19	USA 20	USA 21	CAN 21	USA total	CAN total
2001	641	0	0	7877	2139	-	13	-	0	177	47	111	0	8853	2153
2002	161	0	0	1784	1861	0	7	-	0	5	10	214	75	2174	1943
2003	92	0	0	2825	1613	-	0	-	0	158	0	43	3	3119	1616
2004	161	0	0	5915	78	0	0	0	0	172	12	67	121	6327	198
2005	145	0	0	1133	1260	0	7	0	0	41	29	56	9	1404	1276
2006	1475	0	0	2909	294	0	45	1	0	25	3	16	37	4429	376
2007	274	0	0	5739	753	3	0	0	0	52	6	114	115	6188	868
2008	852	0	0	3090	3654	0	0	0	0	0	0	31	58	3973	3712
2009	4209	0	0	10518	785	0	45	0	0	1180	0	31	136	15937	966
2010	1497	4	0	2371	1579	18	74	4	0	61	151	161	39	4266	1691
2011	2139	0	3	2511	880	14	0	0	0	63	0	20	841	4749	1720
2012	49	0	0	4888	389	0	0	0	0	29	0	13	49	4979	438
2013	164	0	0	1255	542	0	0	0	0	260	0	617	28	2296	570

Table 11. Yellowtail Flounder biomass (mt) index by strata of Georges Bank (see Figure 2) from the DFO survey.

Year	CAN 5Z1	CAN 5Z2	USA 5Z3	USA 5Z4	USA total	CAN total
1987	69	750	102	343	445	819
1988	30	253	136	816	952	283
1989	29	111	50	281	331	140
1990	39	358	129	1053	1181	397
1991	57	444	262	996	1258	501
1992	119	432	327	1599	1925	550
1993	59	1634	178	771	949	1693
1994	91	501	745	1417	2162	591
1995	35	785	487	719	1206	820
1996	35	2799	1229	1241	2470	2833
1997	868	2464	2431	7529	9960	3332
1998	93	2484	613	1102	1715	2577
1999	190	6616	408	10452	10860	6806
2000	2019	5526	6430	5974	12404	7545
2001	443	4995	963	15757	16720	5438
2002	66	5052	5854	9727	15581	5118
2003	48	5739	75	10387	10462	5786
2004	84	5637	63	3271	3334	5720
2005	51	1028	392	11886	12278	1079
2006	35	776	962	4805	5767	812
2007	196	2959	102	10088	10189	3155
2008	64491	1656	262	910	1172	66147
2009	70851	1077	45	72	117	71927
2010	5332	3226	178	402	580	8558
2011	1	477	800	2552	3351	479
2012	89	1121	385	4055	4440	1210
2013	212	252	77	157	234	464

Table 12. Resource distribution for eastern Georges Bank Atlantic Cod on the Canadian and USA sides of the international boundary for the NMFS and DFO surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging the NMFS spring and DFO surveys to represent winter-spring and subsequently averaging with NMFS fall which represented summer-fall. Open box highlights current year results.

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1979	73	27	66	34	-	-	69	31	64	36
1980	65	35	57	43	-	-	61	39	65	35
1981	78	22	31	69	-	-	55	45	65	35
1982	67	33	97	3	-	-	82	18	66	34
1983	86	14	47	53	-	-	66	34	67	33
1984	96	4	23	77	-	-	59	41	69	31
1985	100	0	62	38	-	-	81	19	71	29
1986	58	42	62	38	-	-	60	40	74	26
1987	90	10	61	39	84	16	81	19	78	22
1988	99	1	69	31	76	24	86	14	82	18
1989	99	1	62	38	74	26	83	17	85	15
1990	100	0	74	26	89	11	91	9	85	15
1991	100	0	62	38	78	22	85	15	85	15
1992	94	6	83	17	66	34	85	15	85	15
1993	100	0	41	59	61	39	76	24	84	16
1994	100	0	70	30	96	4	91	9	83	17
1995	94	6	87	13	52	48	82	18	83	17
1996	95	5	55	45	73	27	80	20	84	16
1997	100	0	62	38	70	30	83	17	84	16
1998	100	0	96	4	88	12	96	4	84	16
1999	97	3	53	47	77	23	81	19	85	15
2000	100	0	48	52	69	31	79	21	85	15
2001	97	3	74	26	95	5	90	10	84	16
2002	98	2	63	37	95	5	88	12	84	16
2003	81	19	73	27	69	31	76	24	83	17
2004	99	1	81	19	87	13	91	9	80	20
2005	93	7	66	34	34	66	71	29	78	22
2006	97	3	31	69	69	31	73	27	77	23
2007	81	19	40	60	87	13	72	28	78	22
2008	100	0	57	43	91	9	87	13	79	21
2009	82	18	75	25	100	0	85	15	80	20
2010	96	4	51	49	34	66	69	31	81	19
2011	97	3	82	18	92	8	92	8	82	18
2012	81	19	59	41	71	29	73	27	82	18
2013	97	3	77	23	78	22	87	13	83	17

Table 13. Resource distribution for eastern Georges Bank Haddock on the Canadian and USA sides of the international boundary for the NMFS and DFO surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging over all surveys. Open box highlights current year results.

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1979	70	30	75	25	-	-	72	28	66	34
1980	88	12	35	65	-	-	61	39	69	31
1981	86	14	45	55	-	-	65	35	72	28
1982	95	5	67	33	-	-	81	19	74	26
1983	87	13	79	21	-	-	83	17	78	22
1984	95	5	51	49	-	-	73	27	82	18
1985	81	19	87	13	-	-	84	16	84	16
1986	100	0	84	16	-	-	92	8	84	16
1987	98	2	86	14	97	3	94	6	84	16
1988	99	1	43	57	68	32	70	30	83	17
1989	98	2	41	59	93	7	77	23	81	19
1990	98	2	86	14	72	28	86	14	80	20
1991	97	3	86	14	61	39	81	19	82	18
1992	86	14	79	21	68	32	78	22	84	16
1993	100	0	94	6	64	36	86	14	86	14
1994	100	0	100	0	99	1	100	0	86	14
1995	100	0	61	39	98	2	86	14	88	12
1996	100	0	14	86	94	6	69	31	89	11
1997	100	0	92	8	90	10	94	6	87	13
1998	99	1	89	11	100	0	96	4	86	14
1999	100	0	46	54	97	3	81	19	85	15
2000	99	1	42	58	80	20	74	26	81	19
2001	96	4	80	20	95	5	91	9	78	22
2002	98	2	33	67	69	31	67	33	76	24
2003	75	25	79	21	74	26	76	24	74	26
2004	86	14	34	66	93	7	71	29	72	28
2005	78	22	53	47	87	13	73	27	69	31
2006	94	6	46	54	59	41	66	34	67	33
2007	65	35	36	64	86	14	62	38	64	36
2008	100	0	12	88	67	33	60	40	61	39
2009	46	54	26	74	100	0	57	43	61	39
2010	77	23	34	66	65	35	59	41	59	41
2011	75	25	64	36	75	25	72	28	57	43
2012	97	3	38	62	44	56	60	40	55	45
2013	31	69	49	51	44	56	41	59	52	48

Table 14. Resource distribution for Georges Bank Yellowtail Flounder on the Canadian and USA sides of the international boundary for the NMFS and DFO surveys, the distribution resulting from combining the surveys, and the smoothed resource distribution. The combined distribution was obtained by averaging over all surveys. Open box highlights current year results.

Year	NMFS fall		NMFS spring		DFO		Combined surveys		Smoothed	
	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA	%CAN	%USA
1979	11	89	34	66	-	-	22	78	18	82
1980	56	44	58	42	-	-	57	43	20	80
1981	4	96	14	86	-	-	9	91	23	77
1982	25	75	22	78	-	-	23	77	25	75
1983	29	71	30	70	-	-	30	70	27	73
1984	16	84	44	56	-	-	30	70	32	68
1985	28	72	48	52	-	-	38	62	36	64
1986	19	81	64	36	-	-	42	58	37	63
1987	49	51	29	71	65	35	48	52	35	65
1988	34	66	24	76	23	77	27	73	32	68
1989	7	93	47	53	30	70	28	72	30	70
1990	10	90	17	83	25	75	17	83	31	69
1991	11	89	43	57	28	72	28	72	36	64
1992	65	35	64	36	22	78	51	49	42	58
1993	78	22	63	37	64	36	68	32	47	53
1994	70	30	54	46	21	79	48	52	50	50
1995	50	50	71	29	40	60	54	46	51	49
1996	15	85	54	46	53	47	41	59	50	50
1997	49	51	85	15	25	75	53	47	50	50
1998	62	38	36	64	60	40	53	47	48	52
1999	50	50	66	34	39	61	52	48	46	54
2000	16	84	63	37	38	62	39	61	44	56
2001	20	80	45	55	25	75	30	70	43	57
2002	47	53	62	38	25	75	44	56	42	58
2003	34	66	85	15	36	64	52	48	40	60
2004	3	97	59	41	63	37	42	58	38	62
2005	48	52	31	69	8	92	29	71	35	65
2006	8	92	41	59	12	88	20	80	35	65
2007	12	88	66	34	24	76	34	66	38	62
2008	48	52	62	38	98	2	69	31	42	58
2009	6	94	48	52	100	0	51	49	44	56
2010	28	72	44	56	94	6	55	45	41	59
2011	27	73	4	96	13	87	14	86	39	61
2012	8	92	11	89	21	79	13	87	37	63
2013	20	80	60	40	67	33	49	51	33	67

Table 15. Resource (a) utilization and (b) distribution of eastern Georges Bank Atlantic Cod and Haddock, and Georges Bank Yellowtail Flounder (Ytl) and the weightings used in the Canada/USA allocation sharing formula. Allocation shares are updated annually based on resource distribution. The weighting of resource utilization to resource distribution changed from an initial ratio of 40:60 to 10:90 by 2010.

a)

<i>Resource Utilization</i>			
Country	Cod	Haddock	Ytl
USA	40%	45%	98%
CANADA	60%	55%	2%

b)

Country	<i>Resource Distribution</i>				<i>Weighting</i>			<i>Allocation Shares</i>		
	Survey Year	Cod	Haddock	Ytl	Fishing Year	Utilization	Distribution	Cod	Haddock	Ytl
USA	2000	18%	20%	54%	2002	40%	60%	27%	30%	72%
CANADA		82%	80%	46%				73%	70%	28%
USA	2001	14%	16%	64%	2003	40%	60%	24%	28%	78%
CANADA		86%	84%	36%				76%	72%	22%
USA	2002	12%	26%	62%	2004	40%	60%	23%	34%	76%
CANADA		88%	74%	38%				77%	66%	24%
USA	2003	18%	27%	56%	2005	35%	65%	26%	33%	71%
CANADA		82%	73%	44%				74%	67%	29%
USA	2004	14%	29%	56%	2006	30%	70%	22%	34%	69%
CANADA		86%	71%	44%				78%	66%	31%
USA	2005	21%	29%	63%	2007	25%	75%	26%	33%	72%
CANADA		79%	71%	37%				74%	67%	28%
USA	2006	26%	32%	73%	2008	20%	80%	29%	35%	78%
CANADA		74%	68%	27%				71%	65%	22%
USA	2007	29%	36%	73%	2009	15%	85%	31%	37%	77%
CANADA		71%	64%	27%				69%	63%	23%
USA	2008	23%	40%	60%	2010	10%	90%	25%	40.5%	64%
CANADA		77%	60%	40%				75%	59.5%	36%
USA	2009	17%	43%	50%	2011	10%	90%	19%	43%	55%
CANADA		83%	57%	50%				81%	57%	45%
USA	2010	22%	43%	44%	2012	10%	90%	24%	43%	49%
CANADA		78%	57%	56%				76%	57%	51%
USA	2011	13%	37%	37%	2013	10%	90%	16%	38%	43%
CANADA		87%	63%	63%				84%	62%	57%
USA	2012	20%	38%	80%	2014	10%	90%	22%	39%	82%
CANADA		80%	62%	20%				78%	61%	18%
USA	2013	17%	48%	67%	2015	10%	90%	19%	48%	70%
CANADA		83%	52%	33%				81%	52%	30%

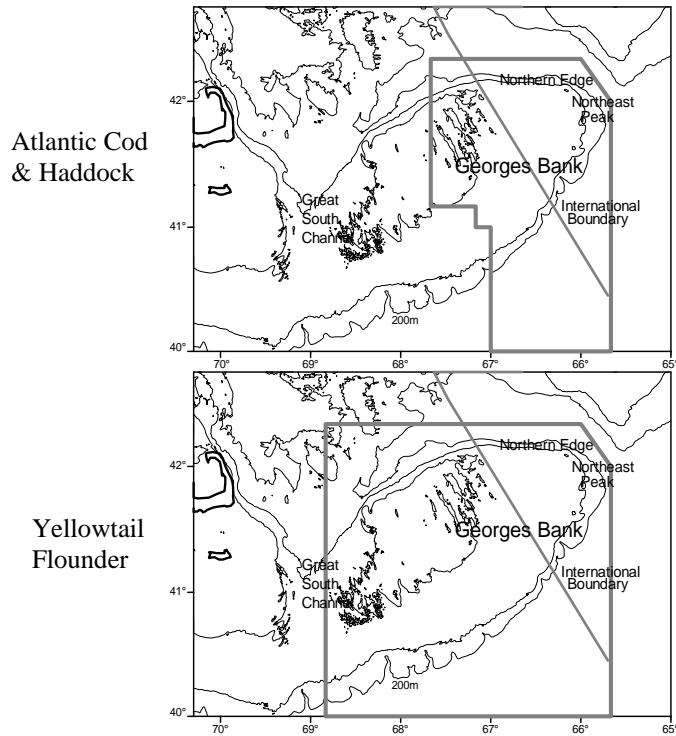


Figure 1. The management areas for Atlantic Cod, Haddock (upper panel), and Yellowtail Flounder (lower panel) on Georges Bank and the Canada/USA boundary line across which resource distribution was determined.

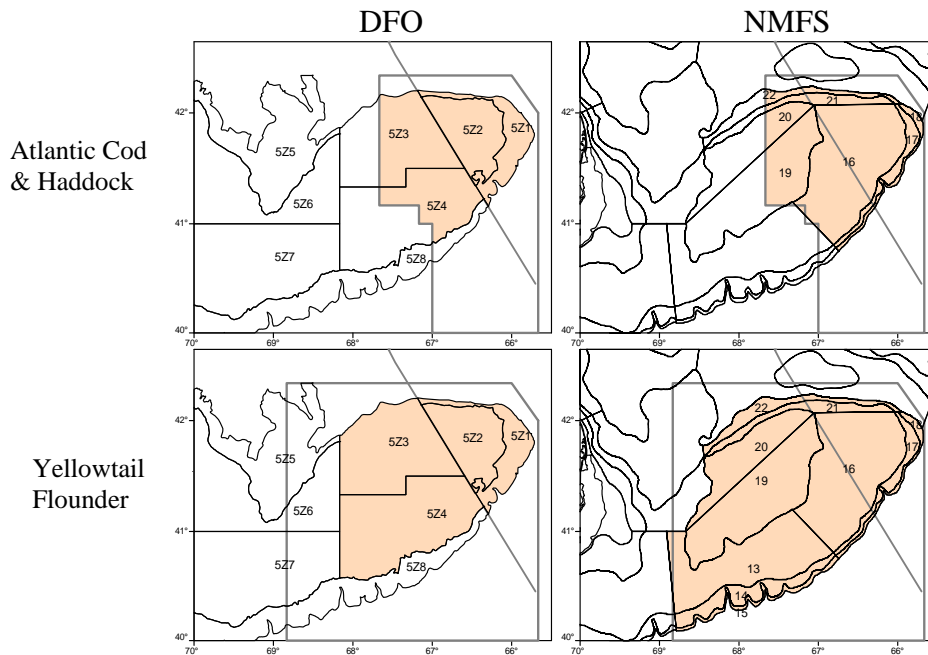


Figure 2. DFO and NMFS survey strata used to develop biomass indices on either side of the Canada/USA boundary for eastern Georges Bank Atlantic Cod and Haddock (upper panels) and Georges Bank Yellowtail Flounder (lower panels) in relation to the management unit borders. Strata boundaries (thin black lines) with strata labels are shown. The shaded area represents the strata and strata sections that were used to approximate the respective management units (thick grey lines).

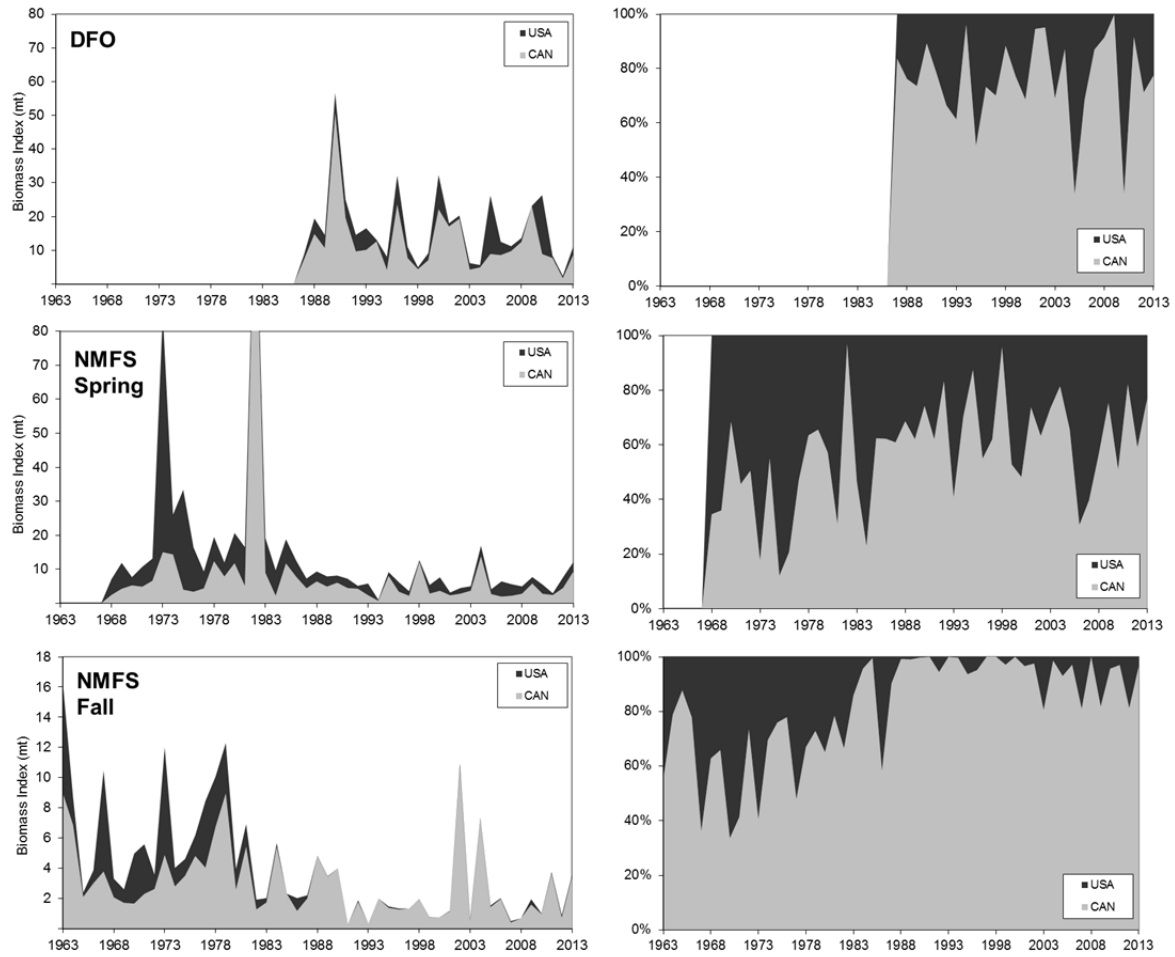


Figure 3. Relative indices of biomass and percentage resource distribution in relation to the international boundary for Atlantic Cod on eastern Georges Bank.

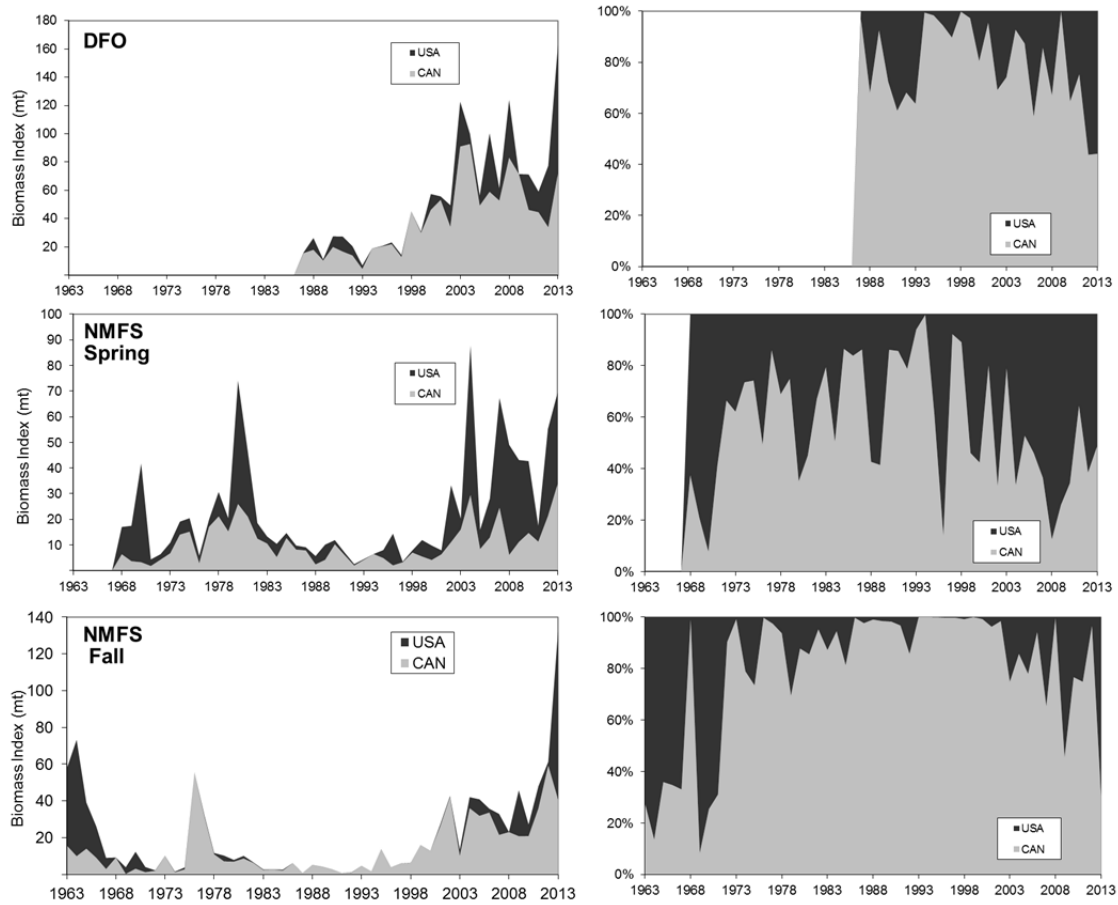


Figure 4. Relative indices of biomass and percentage resource distribution in relation to the international boundary for Haddock on eastern Georges Bank.

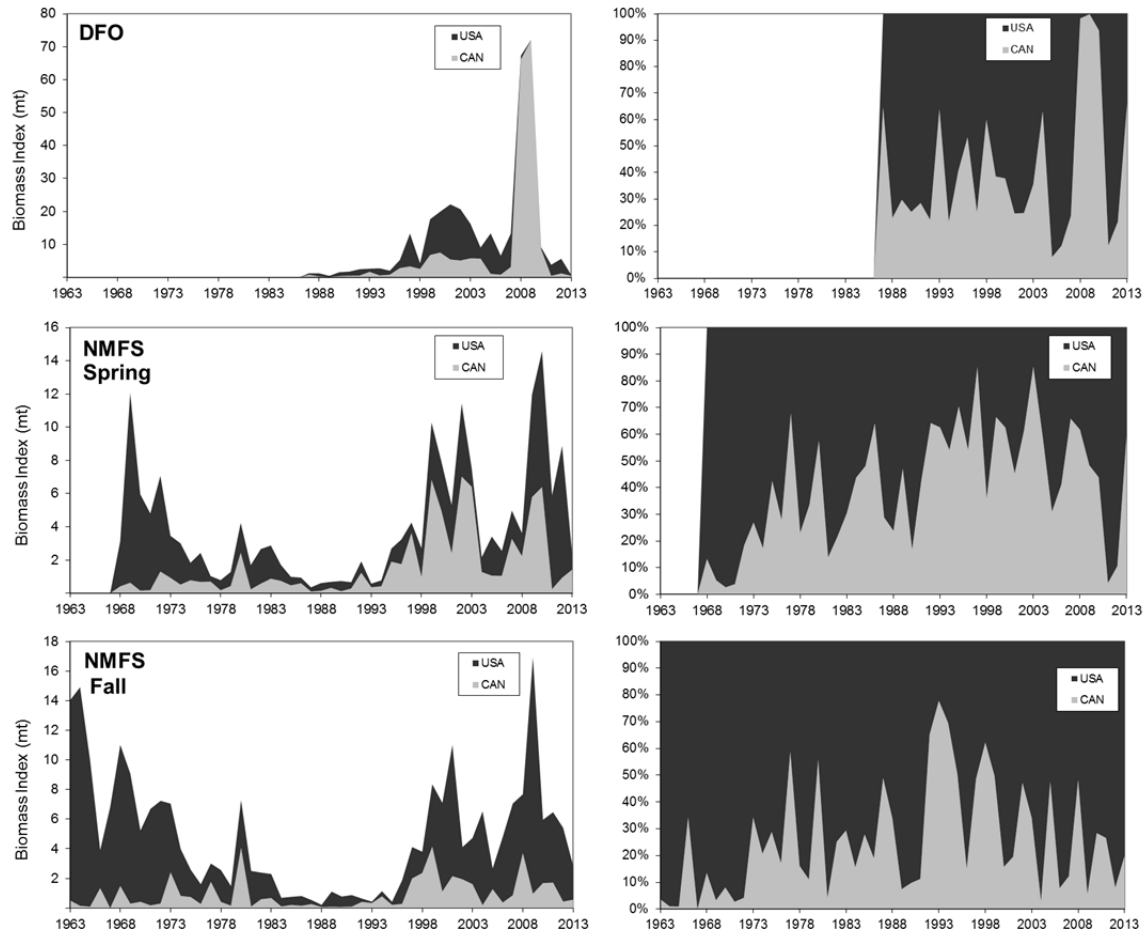


Figure 5. Relative indices of biomass and percentage resource distribution in relation to the international boundary for Yellowtail Flounder on Georges Bank.

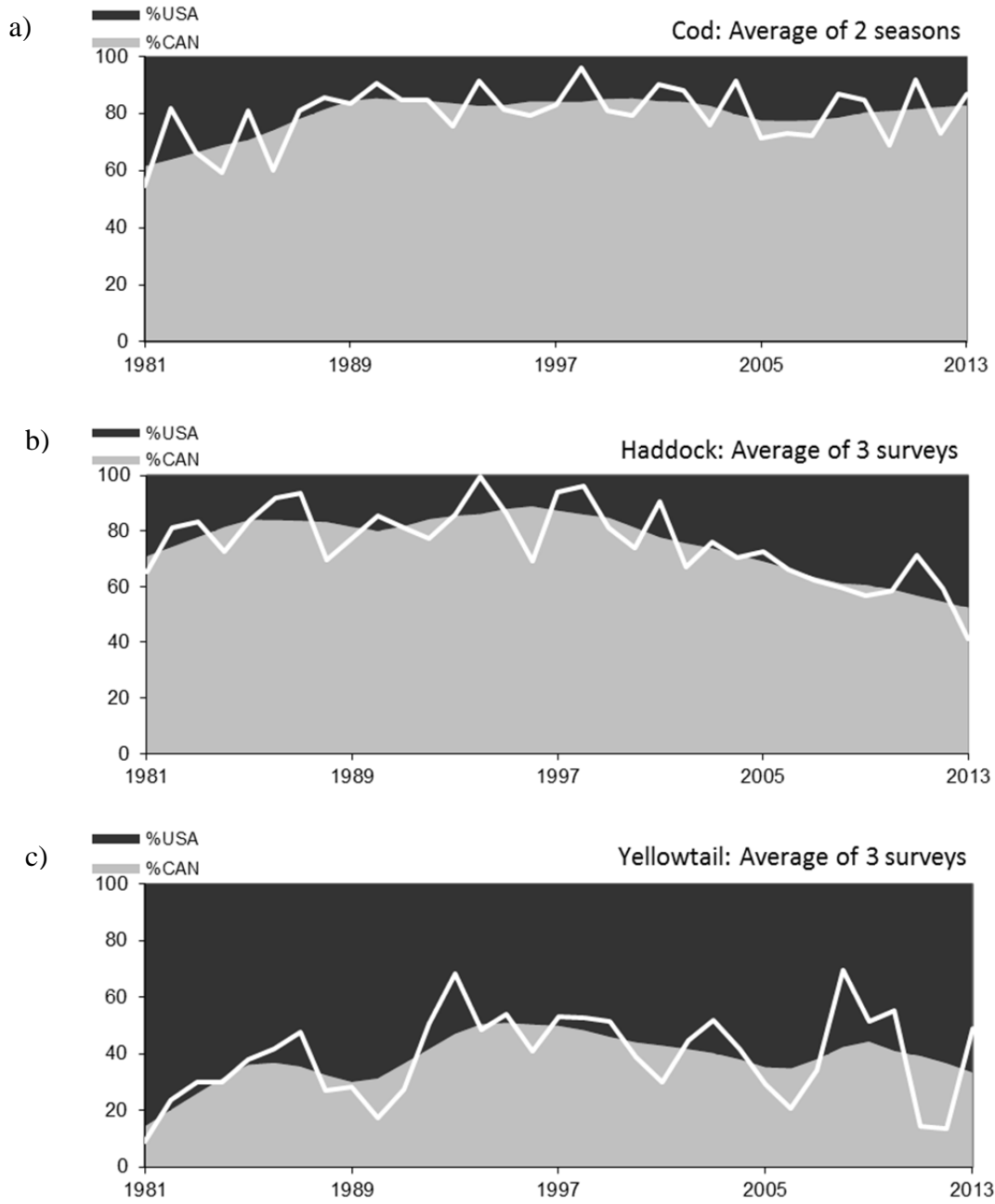


Figure 6. Observed annual percentage (white line) and smoothed trends of proportion of a) eastern Georges Bank Atlantic Cod, b) eastern Georges Bank Haddock, and c) Georges Bank Yellowtail Flounder on the Canadian side of the international boundary.