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An Approach to Estimating the Size and Age Composition of Discarded Yellowtail Flounder from the Canadian Scallop Fishery on Georges Bank, 1973-2004

Heath H. Stone and Stratis Gavaris

Department of Fisheries and Oceans,
Biological Station,
531 Brandy Cove Road,
St. Andrews, New Brunswick
E5B 2L9

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ABSTRACT

A method is described for estimating the size and age composition of yellowtail flounder bycatch from the Canadian Georges Bank scallop fishery for 1973 to 2004. This approach uses bottom trawl survey size composition data for Georges Bank yellowtail flounder adjusted for scallop dredge size selectivity. Adjusted length frequencies were expanded to total discards at size using the ratio of estimated total discards to discard sample weight (calculated from length-weight relationships) and apportioned to age using pooled-sex age-length keys in half year groups. The method is considered to be appropriate for estimating the discarded size and age composition of yellowtail flounder from the Canadian Georges Bank scallop fishery, given the limited available data.

RÉSUMÉ

On décrit ici une méthode d'estimation de la composition, selon la taille et selon l'âge, des prises accessoires de limande à queue jaune dans la pêche canadienne du pétoncle sur le banc Georges de 1973 à 2004. Cette méthode fait appel aux données sur la composition des prises de limande à queue jaune selon la taille dans le relevé au chalut de fond effectué sur le banc Georges, données qui ont été rajustées en fonction de la sélectivité de capture selon la taille propre aux dragues à pétoncles. Les fréquences de longueurs corrigées ont été appliquées à la totalité des rejets selon la taille d'après le rapport entre les estimations de rejets totaux et le poids de l'échantillon de rejets (calculé selon la relation longueur-poids) et elles ont été réparties entre les âges, par groupes de demi-année, selon des grilles de calcul de l'âge en fonction de la longueur chez les deux sexes confondus. On considère que cette méthode convient à l'estimation de la composition des rejets de limande à queue jaune selon la taille et selon l'âge dans la pêche canadienne du pétoncle sur le banc Georges, compte tenu du nombre limité de données disponibles.

INTRODUCTION

Yellowtail flounder discards from the Canadian offshore scallop fishery have not been included in the annual assessments of the Georges Bank yellowtail flounder stock. The Transboundary Resource Assessment Committee recommended during the 2004 assessment that the Canadian fishery catch at age data (CAA) for the assessment should be revised to include discarded catch.

The Canadian offshore scallop fishery on Georges Bank has been in operation since the mid-1950s (Robert et al. 2000) and is considered to be the main source of Canadian yellowtail flounder discards. Prior to 1996, landing of groundfish bycatch by the offshore scallop fishery was permitted, however, it is generally acknowledged that all of the yellowtail flounder bycatch was not landed and that a large proportion was discarded. Management measures established in 1996 prohibit the landing of groundfish (except monkfish) by the Canadian scallop fishery and all bycatch of yellowtail flounder is now discarded. Discards, whether pre- or post -1996, are not recorded in the Canadian fishery statistics but can be estimated from information collected by at-sea observer deployments.

Estimates of yellowtail flounder discards from the Canadian offshore scallop fishery calculated by Van Eeckhaute et al. (2005) are available from 1973 (beginning of VPA time series for Georges Bank yellowtail) through to 2004 and have averaged 546 t during this period (range: 268-815 t) (Table 1). Notable is that discards represent nearly all of the Canadian catch from 1973-1992, before a directed fishery began, and represent a substantial percentage of the total catch (mean: 33%, range: 13-81%) thereafter (Fig. 1).

At-sea length measurements of yellowtail flounder have been recorded by Canadian observers during deployments on offshore scallop vessels in 2001, 2002 and 2004 (Table 1). These measurements were used for estimating the discarded catch at size (DAS) and discarded catch at age (DAA) of yellowtail flounder from the Canadian offshore scallop fishery. Given that there are very few years in the time series with actual length measurements for yellowtail flounder discards, a method is required to calculate the discarded size and age composition for years in which this information is not available. This paper presents an approach to calculating the discard size and age composition for inclusion in the total catch at age for Canada.

DATA and METHODS

At-sea length measurements of yellowtail flounder (total length (TL) to the nearest cm) were obtained by observers from 12 trips monitored during 2001 (Half 1 & Half 2) and 2002 (Half 1), and from 5 trips monitored in 2004 (Half 2) (Table 1). Approximately 50% of the yellowtail bycatch was measured from the 12 trips during the 2001-2002 monitoring program and 25-50% of the yellowtail bycatch was measured from the 5 trips in 2004. A large number of length measurements (n=2,568) were also examined from an observer deployment on a single trip during a gear trials experiment conducted in 1995. However, the size composition of the yellowtail bycatch measured from this trip appeared to be quite irregular and inconsistent with the bycatch size composition from the more recent observed trips. We were unable to resolve why these differences occurred, so this data was not included in further analyses.

For years when observer deployments were conducted in 2001, 2002 and 2004, the observed length compositions by half year were used directly in calculating the discarded catch at age (i.e. 2001: Half 1&2, 2002: Half 1 and 2004: Half 2). Computation by half year was thought to

provide better tracking of annual growth patterns of Georges Bank yellowtail flounder, particularly when age length keys by half year are applied to generate the discards at age.

For years other than 2001, 2002 and 2004 (i.e. when observer data was unavailable), a discard length composition was derived by "adjusting" observed bottom trawl survey length compositions. To develop the ratios for adjusting the bottom trawl survey length compositions, yellowtail flounder bycatch size frequencies for 2001, 2002 and 2004 were grouped by half year and compared with yellowtail size frequencies from the same year DFO survey CAS and NMFS spring and fall survey CAS. The 2001 and 2002 Half 1 bycatch had a size frequency which was similar to that of the same year DFO and NMFS spring survey CAS (Fig. 2), while the 2001 and 2004 Half 2 bycatch size composition was similar to the same year NMFS fall surveys (Fig. 3). Fewer small yellowtail (i.e. < 30 cm TL) were captured by the scallop dredges compared to the survey trawls.

While the survey CAS originates from a larger geographic area (i.e. all of Georges Bank) compared to the Canadian scallop fishery (i.e. eastern Georges Bank), comparisons of yellowtail flounder CAS from DFO survey strata representative of the Canadian (Stratum 5Z2) and US (Stratum 5Z4) sides of the management area for 2000-2004 were quite similar (Fig. 4). Therefore, it was considered that differences in yellowtail size composition due to mismatch in spatial coverage between surveys and the Canadian Georges Bank scallop fishery would be minimal. Furthermore, because NMFS fall survey catches are quite low for some years, all of the available length data is required for analyses.

The derived DAS for first or second half of a year, y_1 and y_2 respectively, was obtained by multiplying the survey length composition for that half year by an "adjusting" ratio and scaling that to the total number discarded, ${}^{D}N_{l,h}$, using two equations:

$$ {}^{D}p_{l,h} = \frac{{}^{S}p_{l,h}\, r_{l,h}}{\sum_{l} {}^{S}p_{l,h}\, r_{l,h}} $$

and

$$ {}^{D}N_{l,h} = {}^{D}p_{l,h} \frac{D}{\sum_{l} w_{l,h}\, {}^{D}p_{l,h}} $$

The "adjusting" ratio is the ratio of the scallop length composition to the survey length composition for a half year when both were observed. In the above equations, *p* denotes proportion, *l* denotes length, *h* denotes half year, *r* is the "adjusting ratio" by length and half, *D* is the total discards in weight for the half year (Table 1), w_l is the weight at length and r_h is the "adjusting" ratio for the half year. Superscripts *D* and *S* refer to discards in the scallop fishery and observed survey values, respectively, and *N* is numbers of fish.

The approach is illustrated using simulated data. First, population numbers at length were constructed for two years. Survey catch and bycatch numbers at length were generated from these using different survey and bycatch selectivity ogives. The discarded CAS for year 2 was then estimated using the above equation with the "adjusting" ratio calculated from year 1 data. The estimated discard CAS matches the observed CAS for year 1 exactly as no random error was introduced (Fig. 5). This approach assumes that survey and bycatch selectivity remains the same over years.

To apply this approach, a single "adjusting" ratio for each length for each half year was obtained by pooling the observed ratios from 2001, 2002 and 2004 and calculating a smoothed line through the data (Fig. 6) using LOESS (Cleveland 1979). The lowest and highest values respectively were extrapolated below and above lengths used for smoothing. The Half 2 "adjusting" ratio was steeper than that for Half 1, with an asymptote at 34 cm compared to 43 cm and required more smoothing because the ratio data for the 2001 and 2004 fall surveys was quite variable, especially at lengths > 35cm. The divergence of the points in Half 2 for large sizes is of concern with data from 2001 showing a strong dome and data from 2004 showing a continual increase (Fig 6). These differences are not assumed to be representative and likely reflect low and variable fall survey catches of yellowtail at larger sizes.

The smoothed "adjusting" ratio for Half 1 was then applied to the average proportion at length by year for DFO and NMFS spring surveys from 1987-2004, and to the proportion at length for NMFS spring surveys for 1973-1986 to generate Half 1 discard catch at size for 1973-2004. (Note: Since the DFO survey begins in 1987, only the NMFS spring series can be used for the earlier period, 1973-1986). The Half 2 discard catch at size for 1973-2003 was generated from the smoothed Half 2 "adjusting" ratio applied to the proportion at length from the 1973-2003 NMFS fall surveys.

Half year weight at length was derived from the length-weight relationship $w = \alpha L^{\beta}$, where $\alpha = 1.9143 \times 10^{-6}$ and $\beta = 3.451$ for Half 1, and $\alpha = 1.1298 \times 10^{-5}$ and $\beta = 2.937$ for Half 2 (Lux 1969). The half year age length keys used for aging yellowtail flounder discards at size from the offshore scallop fishery from 1973 to 2004 were developed using the following combined age samples: Half 1 US commercial fishery + Half 1 US observer sampling + NMFS spring survey, and Half 2 US commercial fishery + Half 2 US observer sampling + NMFS fall survey (Table 2). Additional ages for 2004 were available from the DFO survey (Half 1) and from the Canadian commercial fishery (Half 2).

RESULTS AND CONCLUSIONS

The estimated discarded catch at size was more variable for years prior to 1997, when yellowtail abundance was generally lower in the surveys (Fig. 7). During these earlier years, the size composition was characterized by many modes in the size frequency distribution. The estimated discarded catch at age for 1973-2004 was dominated by ages 2, 3 and 4, with high numbers of age 1 fish in some years which may reflect recruitment events (Table 3, Fig. 8). It is difficult to track yearclasses in the CAA for discards, but this is not surprising since cohorts cannot be easily tracked in the CAA for commercial landings. The weight at age for discards was fairly consistent for ages 1 through 6, but was somewhat more variable for ages 7 and older due to low numbers of age samples for large fish (Table 4; Fig. 9).

Given the paucity of data, this method is considered appropriate for estimating the discarded size and age composition of yellowtail flounder from the Canadian offshore scallop fishery. These discards at age can be added to the Canadian fishery CAA to give the total CAA for Canada from 1973-2004. In the future, it is anticipated that yellowtail flounder discards at age from the Georges Bank scallop fishery will be based on the observed size composition of the bycatch monitored by Canadian at-sea observers routinely deployed on offshore scallop vessels.

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LITERATURE CITED

Cleveland, W.S. 1979. Robust locally weighted regression and smoothing scatterplots. Journal of American Statistical Association 74: 829-836.

Lux, F.E. 1969. Length-weight relationships of six New England flatfishes. Trans. Am. Fish. Soc. 98(4): 617-621.

Robert, G., G.A.P. Black, M.A.E. Butler, and S.J. Smith. 2000. Georges Bank scallop stock assessment, 1999. CSAS Res. Doc. 2000/1684p.

Van Eeckhaute, L., S. Gavaris, and H. Stone. 2005. Estimation of cod, haddock and yellowtail flounder discards from the Canadian Georges Bank scallop fishery from 1960 to 2004. DFO TRAC Ref. Doc. 2005/07.

Table 1. Number of length measurements by half year obtained by Canadian observers for yellowtail flounder discards from the offshore scallop fishery on Georges Bank in 2001, 2002 and 2004, and half year discard estimates (mt) for 1973-2004 from Van Eeckhaute et al. (2005).

	Number of lengths			Estimated discards (mt)		
Year	Half1	Half2	**Total**	Half1	Half2	**Total**
1973				188	190	**378**
1974				253	365	**619**
1975				301	420	**722**
1976				313	306	**619**
1977				257	328	**584**
1978				345	342	**687**
1979				378	344	**722**
1980				359	225	**584**
1981				388	299	**687**
1982				297	205	**502**
1983				285	175	**460**
1984				254	227	**481**
1985				306	416	**722**
1986				225	132	**357**
1987				290	246	**536**
1988				308	276	**584**
1989				376	160	**536**
1990				303	192	**495**
1991				267	187	**454**
1992				280	222	**502**
1993				290	149	**440**
1994				319	120	**440**
1995				163	105	**268**
1996				295	94	**388**
1997				311	127	**438**
1998				511	197	**708**
1999				498	99	**597**
2000				301	114	**415**
2001	3102	6457	**9559**	618	197	**815**
2002	6500		**6500**	396	97	**493**
2003				551	259	**809**
2004		4723	**4723**	305	117	**422**

Table 2. Number of ages available from NMFS spring surveys, US commercial fishery and US observer sampling by half year for constructing age length keys to apply to Georges Bank yellowtail flounder bycatch at size, 1973-2003. (Note: The 2004 Half 1 & Half 2 ages were supplemented with an additional 355 ages from the DFO survey and 162 ages from the Canadian commercial fishery to give an overall total of 1316 and 741 ages, respectively).

	Half 1				Half 2			
Year	NMFS Spr.	US Comm.	US Obs.	**Total**	NMFS Fall	US Comm.	US Obs.	**Total**
1973	520	1611		**2131**	378	1403		**1781**
1974	343	1719		**2062**	420	2399		**2819**
1975	156	1700		**1856**	187	3213		**3400**
1976	299	1538		**1837**	106	1506		**1612**
1977	120	718		**838**	240	1819		**2059**
1978	84	456		**540**	428	751		**1179**
1979	296	195		**491**	205	1475		**1680**
1980	255	646		**901**	432	660		**1092**
1981	149	714		**863**	171	537		**708**
1982	209	383		**592**	172	340		**512**
1983	180	712		**892**	159	342		**501**
1984	69	87		**156**	58	203		**261**
1985	81	474		**555**	67	707		**774**
1986	91	360		**451**	76	380		**456**
1987	18	329		**347**	34	383		**417**
1988	50	313		**363**	12	394		**406**
1989	69	383		**452**	79	272		**351**
1990	71	331		**402**	108	326		**434**
1991	75	228		**303**	64	172		**236**
1992	104	174	18	**296**	45	298		**343**
1993	43	533	130	**706**	64	618		**682**
1994	75	53		**128**	104	353	73	**530**
1995	92	164		**256**	41	22		**63**
1996	155	146	65	**366**	49	173	9	**231**
1997	176	516	221	**913**	139	61	106	**306**
1998	181	231	74	**486**	173	61	35	**269**
1999	200	195	377	**772**	179	105	731	**1015**
2000	137	200	2705	**3042**	131	405	2863	**3399**
2001	133	404	261	**798**	190	193	25	**408**
2002	562	313	195	**1070**	119	239	467	**825**
2003	137	640	856	**1633**	115	476	75	**666**
2004	94	866		**960**	127	452		**579**

Table 3. Estimates of discards at age (numbers in 000's) for Georges Bank yellowtail flounder bycatch in the Canadian offshore scallop fishery, 1973-2004.

	Age													
Year	1	2	3	4	5	6	7	8	9	10	11	12	6+	**Total**
1973	12	282	312	190	69	25	5	1	1	0	0		31	**897**
1974	224	527	387	257	97	25	12	2	2	0	0	0	42	**1535**
1975	264	1100	314	146	90	37	14	6	0	1			58	**1971**
1976	20	905	350	77	42	18	17	8	6	1			49	**1444**
1977	48	483	604	117	23	9	5	2	1	0			18	**1293**
1978	303	405	485	229	74	16	7	5	4	0	2		34	**1530**
1979	88	988	333	186	71	26	16	5	5				52	**1718**
1980	9	389	741	99	26	9	1	1	1				12	**1277**
1981	52	367	600	353	57	13	1	2	3				19	**1448**
1982	100	574	344	148	62	6	1	4					12	**1239**
1983	5	237	495	138	49	12	3	8	4				26	**950**
1984	86	98	263	302	202	36	0	22					58	**1009**
1985	317	994	233	160	102	12	3						15	**1821**
1986	19	524	131	35	40	27	0	8					36	**785**
1987	16	586	317	203	57	8	6	5	4				23	**1202**
1988	16	586	317	203	57	8	6						14	**1193**
1989	5	612	429	157	40	6	4	0					11	**1253**
1990	12	177	831	172	32	3	3						6	**1229**
1991	251	92	230	479	77	8							8	**1138**
1992	25	736	401	177	82	13	0	1	1				14	**1435**
1993	40	182	416	337	65	11	1						11	**1052**
1994	14	100	136	77	39	5	2	0					7	**374**
1995	36	75	335	219	50	6	4	1					11	**726**
1996	3	157	408	251	68	3	3	2					9	**896**
1997	18	135	269	339	102	10	6	2	1				18	**882**
1998	35	442	504	314	168	63	5	2	0	1			71	**1534**
1999	16	436	410	161	101	38	10	1	1				50	**1175**
2000	3	304	287	151	46	25	10	2	0				37	**828**
2001	30	335	775	294	107	42	18	5	1				66	**1607**
2002	21	248	351	179	77	24	16	11	2	1			54	**931**
2003	13	473	655	285	99	41	22	8	4	1	1		76	**1602**
2004	5	116	309	218	74	36	20	9	6	6	2		79	**800**

Table 4. Estimates of discard mean weight at age at age (kg) for Georges Bank yellowtail flounder bycatch in the Canadian offshore scallop fishery, 1973-2004.

	Age											
Year	1	2	3	4	5	6	7	8	9	10	11	12
1973	0.129	0.281	0.431	0.510	0.604	0.727	0.845	0.872	1.043	0.000	1.170	
1974	0.178	0.332	0.445	0.540	0.623	0.654	0.843	1.059	1.218	0.000	1.496	1.496
1975	0.151	0.319	0.479	0.550	0.643	0.737	0.753	0.748	0.688	0.751		
1976	0.176	0.323	0.562	0.624	0.783	0.800	0.888	1.046	1.155	1.444		
1977	0.162	0.344	0.510	0.615	0.736	0.747	0.760	0.834	0.631	0.704		
1978	0.165	0.306	0.507	0.738	0.866	0.931	1.031	1.139	1.157		0.971	
1979	0.143	0.313	0.484	0.706	0.797	0.893	0.955	1.038	1.421			
1980	0.149	0.294	0.496	0.661	0.853	0.991	1.022	1.048	1.239			
1981	0.145	0.311	0.474	0.622	0.708	1.047	0.899	1.599	1.104			
1982	0.172	0.279	0.467	0.652	0.849	1.203	1.213	1.397				
1983	0.165	0.289	0.460	0.666	0.786	1.081	0.957	1.610	1.239			
1984	0.163	0.227	0.398	0.501	0.686	0.776		1.020				
1985	0.188	0.356	0.534	0.624	0.714	0.755	0.721					
1986	0.216	0.330	0.537	0.776	0.983	1.192	0.704	1.345				
1987	0.195	0.363	0.543	0.735	1.030	1.251	1.099	0.704	0.746			
1988	0.181	0.336	0.562	0.719	0.810	1.021	0.838					
1989	0.105	0.283	0.484	0.712	0.835	0.872	1.005	1.128				
1990	0.192	0.243	0.381	0.623	0.681	0.683	0.855					
1991	0.155	0.218	0.371	0.512	0.712	1.057						
1992	0.177	0.264	0.340	0.550	0.674	0.931		1.303	1.303			
1993	0.138	0.268	0.396	0.517	0.582	0.728	0.747					
1994	0.154	0.226	0.335	0.487	0.628	0.837	0.826	1.496				
1995	0.165	0.222	0.310	0.465	0.612	0.779	0.898	0.532				
1996	0.157	0.257	0.390	0.526	0.689	0.841	1.093	1.324				
1997	0.177	0.287	0.422	0.566	0.730	0.885	0.827	1.218	1.113			
1998	0.176	0.286	0.413	0.539	0.750	0.996	1.124	1.171	0.000	1.397		
1999	0.173	0.334	0.488	0.687	0.819	0.989	1.336	1.496	1.822			
2000	0.169	0.332	0.475	0.661	0.854	0.988	1.049	1.158	1.104			
2001	0.274	0.338	0.449	0.634	0.810	1.051	1.138	1.303	1.433			
2002	0.214	0.346	0.446	0.653	0.842	1.061	1.183	1.359	1.492	1.428		
2003	0.186	0.346	0.459	0.642	0.809	0.959	1.047	1.136	1.324	1.397	1.708	
2004	0.229	0.283	0.418	0.567	0.738	0.920	1.045	1.161	1.140	1.204	1.421	

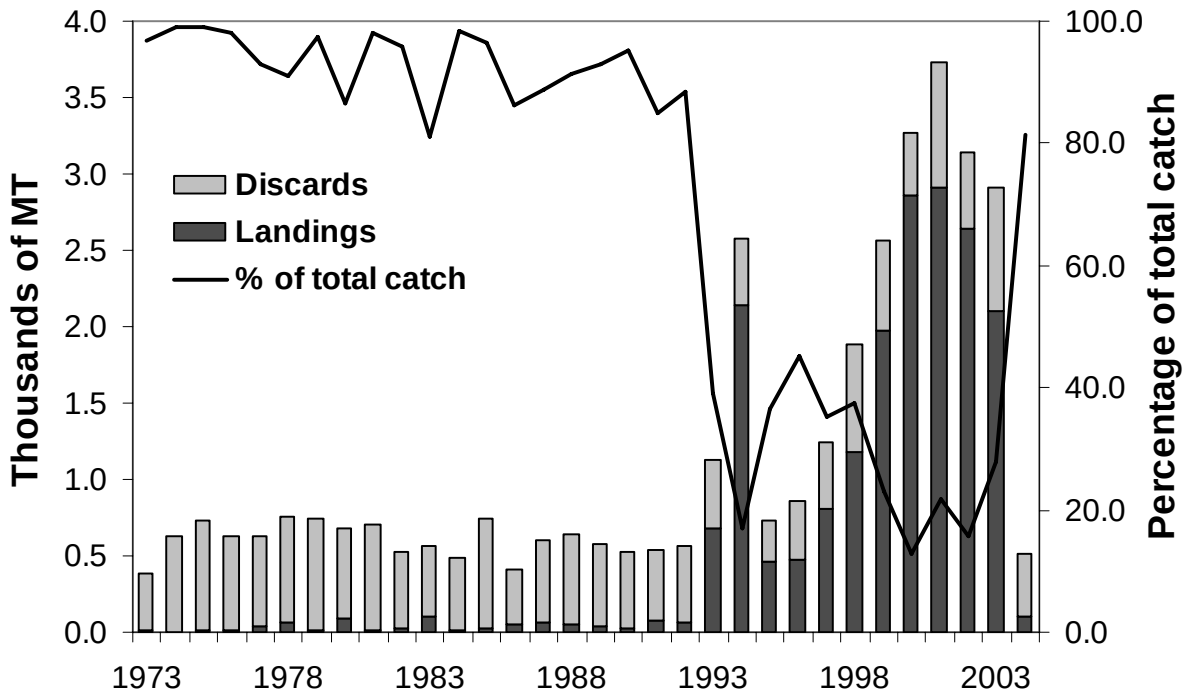

Figure 1. Canadian landings and estimated discards (mt) for Georges Bank yellowtail flounder, 1973-2004. The percentage of total catch (landings + discards) represented by discards is also shown.

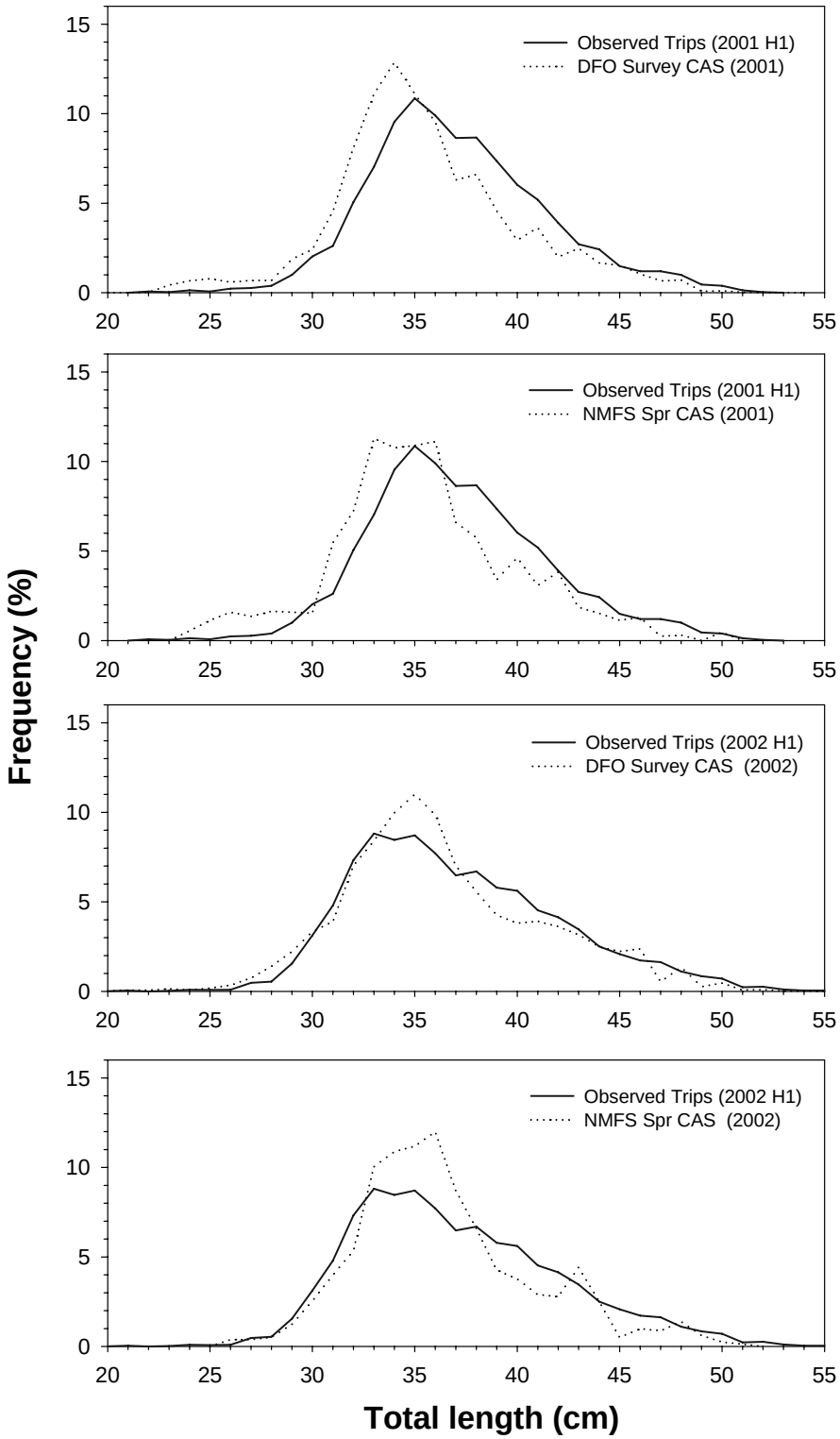

Figure 2. Length frequency comparisons between Georges Bank yellowtail flounder bycatch from observed offshore scallop trips for Half 1 2001 and 2002 *vs.* DFO and NMFS spring survey yellowtail flounder CAS for 2001 and 2002.

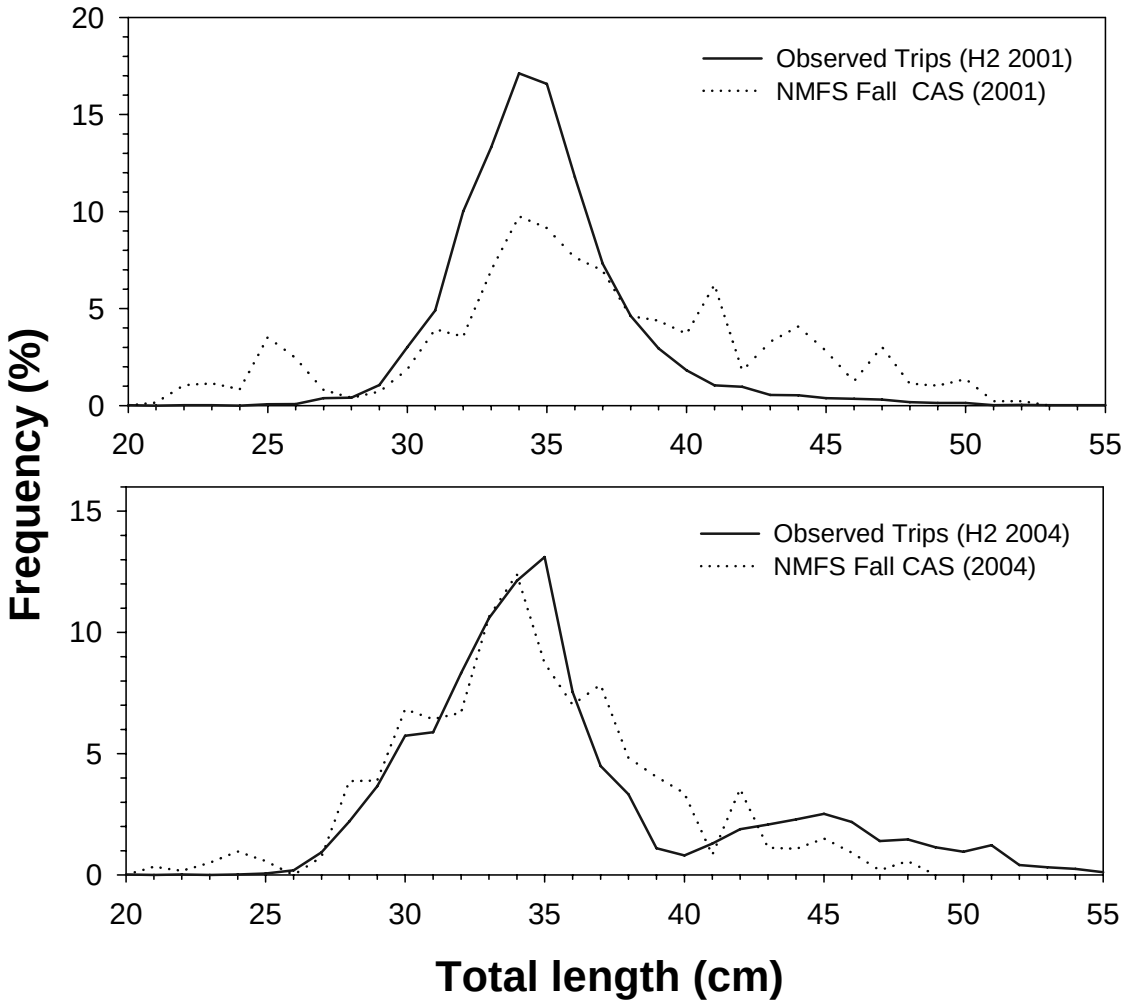

Figure 3. Length frequency comparisons between Georges Bank yellowtail flounder bycatch from observed offshore scallop trips for Half 2 in 2001 and 2004 *vs.* NMFS fall survey yellowtail flounder CAS for 2001 and 2004.

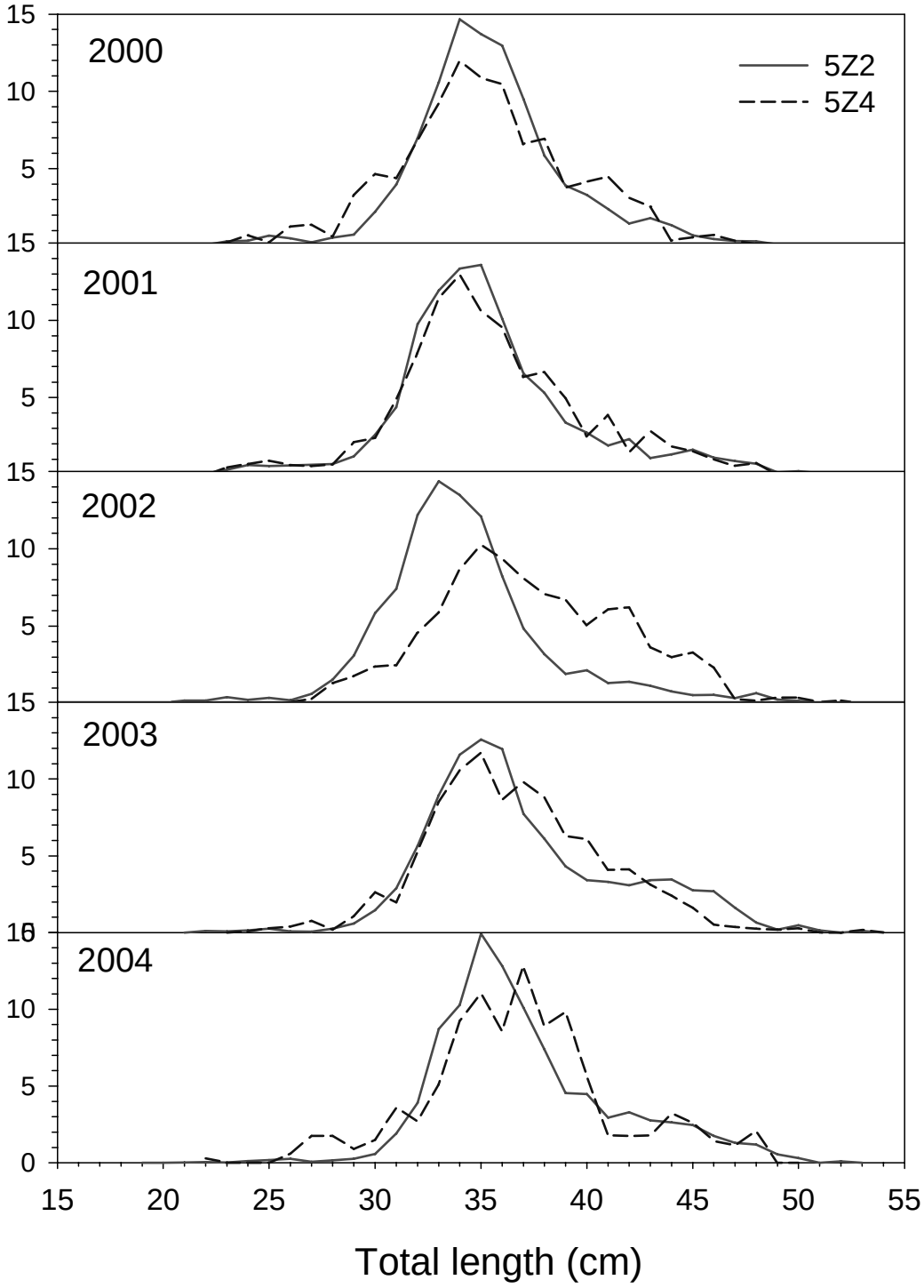

Figure 4. Size composition of Georges Bank yellowtail flounder from DFO survey strata 5Z2 (Canadian portion < 90 m) and 5Z4 (lower half of Closed Area II on US side) for 2000-2004.

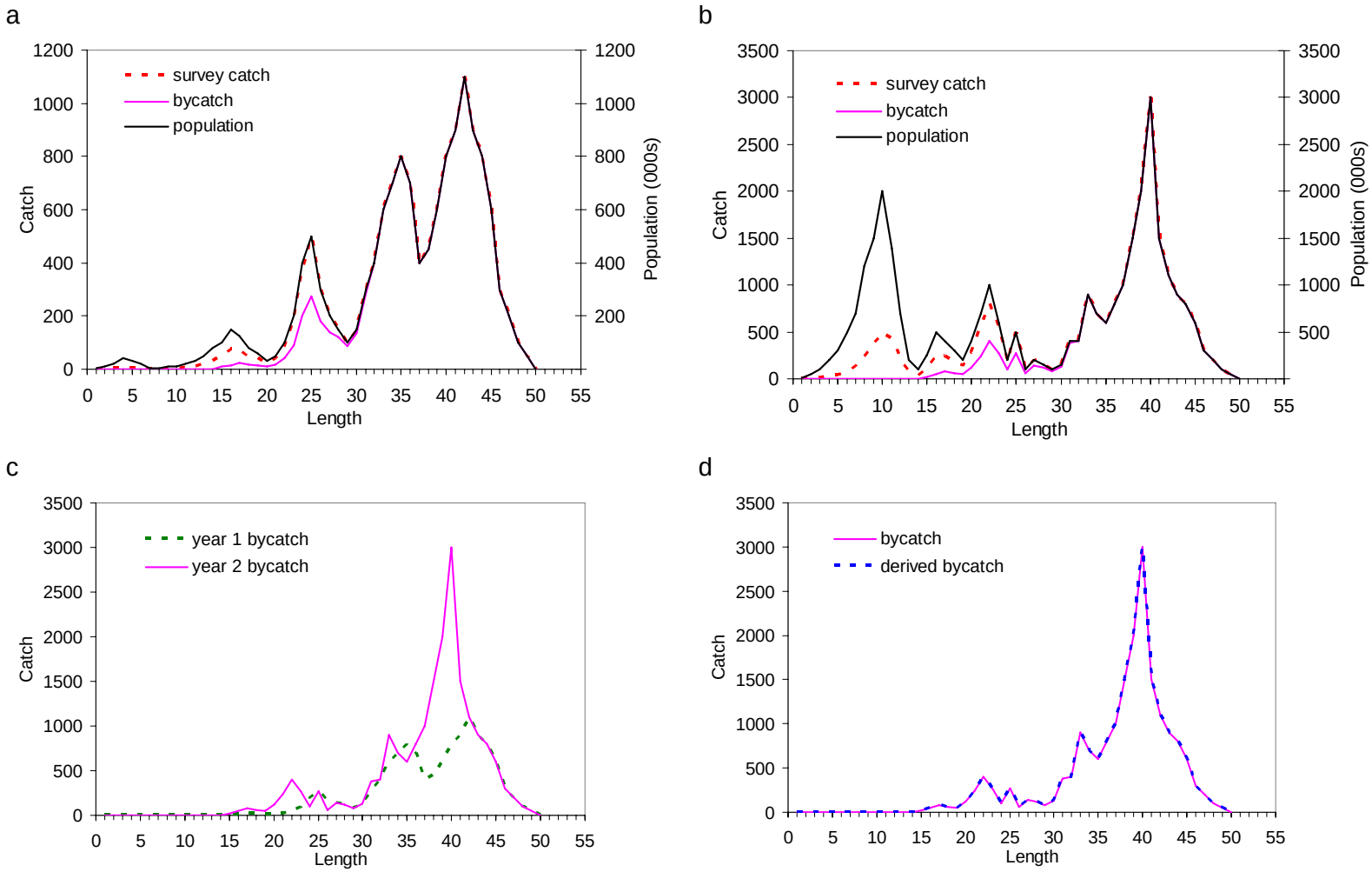

Figure 5. Simulated population numbers, survey catch and bycatch for year 1 (panel a) and year 2 (panel b). Panel c compares the difference in bycatch composition at length from years 1 and 2. Panel d demonstrates that the derived bycatch for year 2 using an "adjusting" ratio calculated from year 1 observations exactly matches the simulated bycatch for year 2.

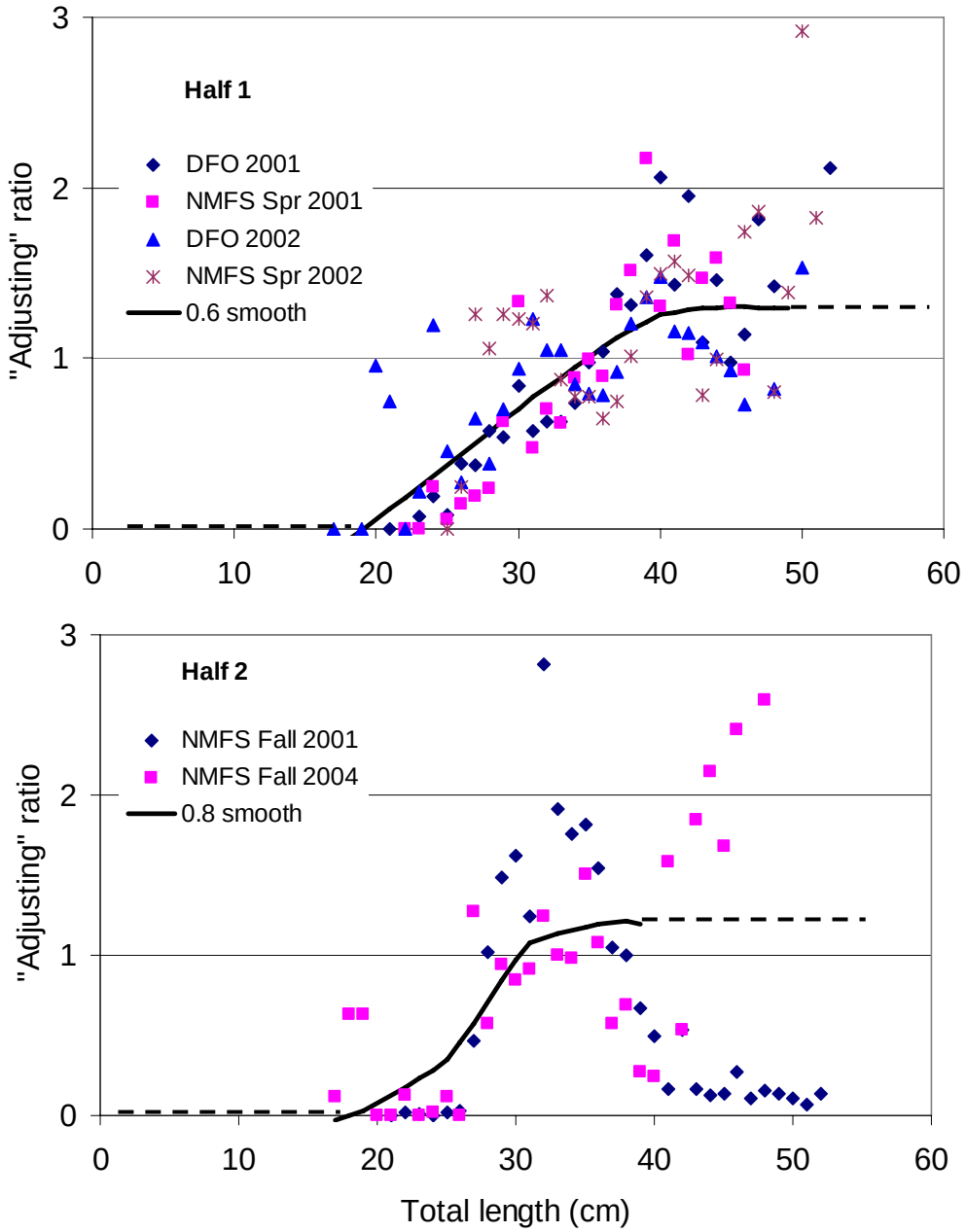

Figure 6. Loess smoothed ”adjusting” ratio for Georges Bank yellowtail flounder bycatch in offshore scallop dredges relative to the 2001 and 2002 DFO and NMFS spring surveys (Half 1) and 2001 and 2004 NMFS fall surveys (Half 2) by 1 cm size groupings.

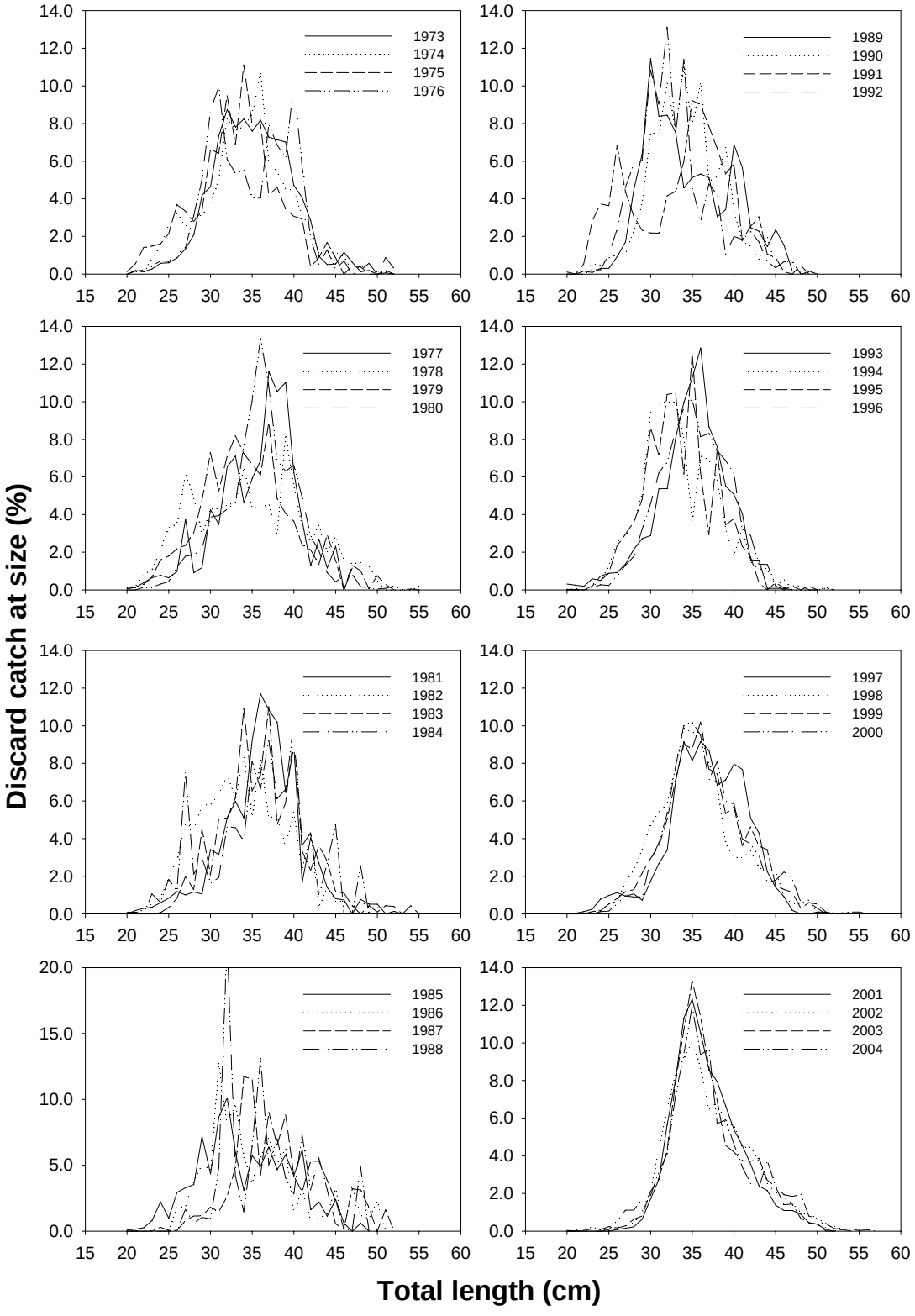

Figure 7. Estimated discarded catch at size (%) by year (1973-2004) for Georges Bank yellowtail flounder bycatch in the Canadian offshore scallop fishery.

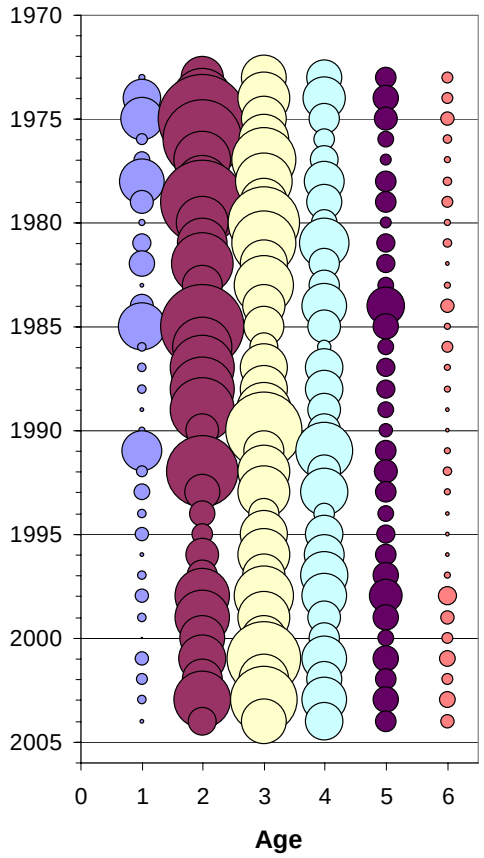

Figure 8. Discards at age for yellowtail flounder from the Canadian scallop fishery on Georges Bank, 1973-2004. Circle size is proportional to abundance.

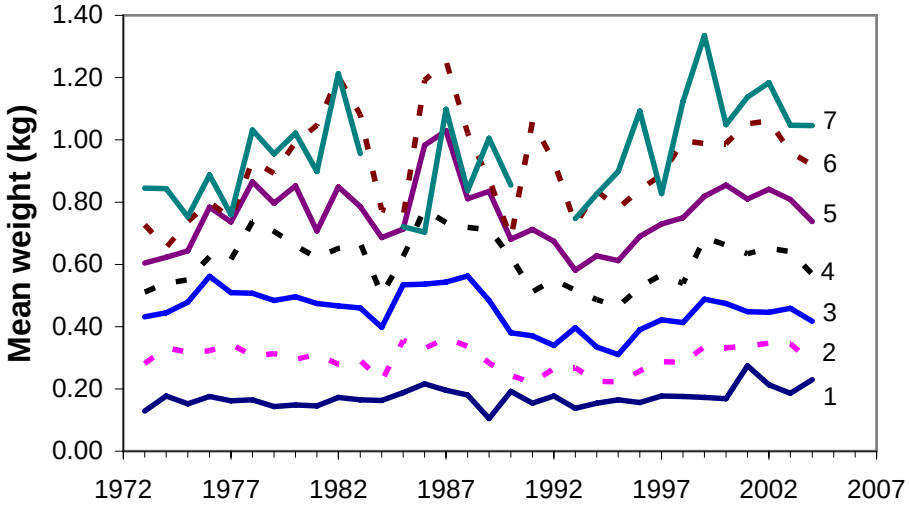

Figure 9. Mean weight at age (kg) for yellowtail flounder bycatch from the Georges Bank scallop fishery, 1973-2004.