A Review of the Standardization of Effort for the Calculation of Discards of Atlantic Cod, Haddock and Yellowtail Flounder from the 2005 to 2011 Canadian Scallop Fishery on Georges Bank

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ABSTRACT

Discards of Atlantic cod, haddock and yellowtail flounder are estimated annually for the Canadian scallop fishery on Georges Bank. The offshore scallop fishery consists of two types of fishing vessels, wet fish (WF) vessels and freezer trawlers (FT). Gavaris et al. (2007) determined that the fishing efficiency between these two fleets differed and derived a conversion factor of 1.2 ($\pm$0.05; SE); where 1 FT hour = 1.2 ($\pm$0.05) WF hour. Discards have since been derived using effort in standardized freezer trawler hours and there is no adjustment for the number of dredges or size of dredges. However, the fishery statistics for all offshore scallop trips includes information on the number of dredges and gear width that can be used to compare between the current standardized freezer trawler effort approach (effort in hours (h)) and an approach using effort in hour×meters (hm). By applying a multiplicative main effects model to catch rate data from 2005 to 2011 for the offshore scallop fishery, a conversion factor of 1.26 ($\pm$0.05; SE), where 1 FT hour = 1.26 $\pm$ 0.05 WF hour, was determined for effort in hours which is consistent with Gavaris et al. (2007). However, fleet was not a significant factor when catch rates in kg•hm-1 were used and therefore no conversion factor in effort between wet fish and freezer trawler vessels is required when effort in hours×meters is used. It is recommended that hm be used as the measure of scallop fishing effort to calculate discards from the 2012 scallop fishery and for subsequent years.

RÉSUMÉ

Les rejets de morue franche, d'aiglefin et de limande à queue jaune sont estimés chaque année dans la pêche canadienne du pétoncle sur le banc de Georges. La flottille de pétoncliers hauturiers comprend deux sortes de bateaux : des bateaux de pêche fraîche et des chalutiers congélateurs. Gavaris et al. (2007) ont déterminé que l'efficacité de pêche entre ces deux types de bateaux était différente et ont calculé un facteur de conversion de 1,2 ($\pm$0,05; effort de pêche du pétoncle); où 1 heure en bateau de pêche fraîche = 1,2 ($\pm$0,05) heure en chalutier congélateur. Depuis, les rejets ont été calculés à l'aide de l'effort en heures normalisées pour les chalutiers congélateurs, et il n'y a pas d'ajustement pour le nombre de dragues ou leur taille. Toutefois, les statistiques relatives à la pêche pour toutes les sorties de pêche hauturière du pétoncle comprennent le nombre de dragues et la largeur des engins pouvant être utilisés pour comparer l'approche actuelle en matière d'effort des chalutiers congélateurs (effort en heures [h]) et une approche utilisant l'effort en heures x mètres (hm). En appliquant un modèle multiplicatif d'effets majeurs aux données sur les taux de prise de 2005 et de 2011 pour la pêche hauturière du pétoncle, un facteur de conversion de 1,26 ($\pm$0,05; effort de pêche du pétoncle), où 1 heure en chalutier congélateur = 1,26 $\pm$ 0,05 heure en bateau de pêche fraîche, a été déterminé pour l'effort en heures, ce qui coïncide avec le facteur déterminé par Gavaris et al. (2007). Cependant, la flottille n'était pas un facteur important lorsque des taux de prise en kg•hm-1 étaient utilisés. Par conséquent, aucun facteur de conversion pour l'effort des bateaux de pêche fraîche et celui des chalutiers congélateurs n'est requis lorsque l'effort en heures x mètres est utilisé. On recommande d'utiliser l'unité heures x mètres (hm) comme mesure de l'effort de pêche du pétoncle afin de calculer les rejets dans la pêche du pétoncle de 2012 et des années suivantes.

INTRODUCTION

Incidental catch not landed (i.e. not recorded in the fishery statistics records) is designated as "discards". Canadian management measures established in 1996 prohibit the landing of groundfish (except monkfish) by the Canadian scallop fishery on Georges Bank. All incidental catches of Atlantic cod, haddock and yellowtail flounder are therefore discarded and these discards have been included in the assessments of these stocks on Georges Bank since 2004 (O'Boyle and Overholtz 2004). Discards of Atlantic cod, haddock and yellowtail flounder from the Canadian scallop fishery for 1960–2004 were first estimated by Van Eeckhaute et al. (2005) and updated for 2005–2008 by Gavaris et al. (2007, 2008, 2009), and for 2009 and 2010 by Van Eeckhaute et al. (2010, 2011).

The offshore scallop fishery consists of two types of fishing vessels, wet fish vessels (WF; scallop draggers that land fresh product) and freezer trawlers (FT; scallop draggers that land frozen product). Gavaris et al. (2007) identified that there was evidence that the fishing efficiency between these two fleets differed and used data from 2004 to 2006 to derive a conversion factor of 1.2 (±0.05; SE); where 1 FT hour = 1.2 (±0.05) WF hour. Effort in hours was used and there was no adjustment for the number of dredges or size of dredges. It was assumed that the amount of gear used on observed trips was representative of the amount of gear used in typical operations. Effort information for observed trips may be obtained from observer records or from fishery statistics, however since the total fleet effort must be obtained from fishery statistics, observed trip effort was also obtained from fishery statistics to ensure consistency.

Included in the fishery statistics for all offshore scallop trips is information on the number of dredges and gear width for all trips. This information therefore allows a comparison between the standardized freezer trawler effort approach (effort in hours (h); Gavaris et al. 2007) and an approach using effort in hour×meters (hm). If the difference in efficiency between WF and FT vessels is mainly due to the number of dredges and gear width, then the use of effort in hour×meters would make a conversion factor unnecessary. In addition, this report also reviews the initial calculation of the WF to FT conversion factor by Gavaris et al. (2007) using data from 2005 to 2011.

DATA AND METHODS

PRORATING

Discards of Atlantic cod, haddock and yellowtail flounder in the Canadian scallop fishery on Georges Bank were estimated by applying a 3-month moving window to discard rates from observed trips in kg•h^{-1} (where hours were standardized FT hours; Gavaris et al. 2007; Table 1) and in kg•hm^{-1} (Table 2). Discard rates obtained from observed trips (trips monitored by DFO accredited at-sea observers) were applied to total monthly effort (h or hm) of the scallop fleet as follows:

$$discards = total\ scallop\ effort \times \left(\frac{observed\ discards}{observed\ scallop\ effort} \right) \qquad (1)$$

This approach is dependent on the assumption that the population density of the incidentally caught species experienced by observed trips, i.e. the ratio (*observed discards / observed scallop effort*), is representative for the whole scallop fishery. The results can therefore be sensitive to inadequate sampling of the spatial/temporal variation in the population density of the incidentally caught species.

The fishery statistics effort can be reported as hours or hours×meters fished for an entire observed trip. Discards from observed trips are only reported for the portion of the fishing activity that was witnessed. It is therefore necessary to prorate witnessed discards to the discards for an entire observed trip. The number of witnessed dredge hauls and the total number of dredge hauls made on an observed trip are recorded. The total discards for a trip are obtained by prorating the witnessed discards by the ratio of total number of dredge hauls to observed number of dredge hauls recorded for the trip.

Prior to 2009, data from fishery statistics for offshore scallop were summarized on the landing date of a fishing trip, where all catch and effort for a trip would be assigned to the month in which the trip landed. Since 2009, fishery statistic information on catch and effort has been summarized by day fished for a fishing trip, where catch and effort for a given day is assigned to the month in which its associated day occurred. To ensure consistency for this analysis, all fishery statistic data from 2005 to 2011 was summarized on day fished. Therefore total fishery effort in hours by month reported here may vary from total fishery effort in hours by month reported in previous documents.

EFFORT STANDARDIZATION

Prior to 2004, virtually none of the scallops landed were caught by freezer trawlers. The prevalence of freezer trawlers has increased since 2004 with freezer trawler landings accounting for 34%, 57%, 63%, 67%, 69%, 67%, 69% and 68% of total landings from 2004 to 2011. Freezer trawlers operate differently than wet fish vessels and sometimes use larger dredges. Therefore Gavaris et al. (2007) expected that the effective fishing intensity exerted by an hour of fishing by a FT was not equivalent to that of a WF trawler. A multiplicative model (Gavaris 1980) was used to derive a conversion factor for standardizing effort, with factors fleet, month, and year using data from January 2004 to September 2006 (Gavaris et al. 2007). NAFO area was initially identified as an additional possible factor, however it was determined that catch rates for area 5Zem were insufficient and highly variable, therefore data from area 5Zem was removed from the analysis and NAFO area was not used as a factor (Gavaris et al. 2007). For the purpose of this analysis, exploratory investigation of the data (Figures 1, 2) indicated sufficient data for the inclusion of NAFO area as a factor. This resulted in the following main effects model:

$$U_{ijkl} = \mu \left(fleet_i \right)\left(month_j \right)\left(year_k \right)\left(area_l \right)\varepsilon_{ijkl} \tag{2}$$

where U_{ijkl} is the scallop catch rate, μ is the overall mean, $fleet_i = 1$ (WF) or 2 (FT), $month_j = 1$ (January), ..., 12 (December), $year_k = 1$ (2005), ..., 7 (2011), NAFO $area_l = 1$ (5Zej) or 2 (5Zem), and ε is the error term.

As described in Gavaris et al. (2007), by taking logarithms of both sides, this equation can be solved using ordinary least squares, where factor effects for any fleet, month, year or area are simply the factor effects (θ) retransformed back to the original scale (ϕ). Assuming that the errors (ε) are distributed according to a Gaussian distribution, an unbiased estimator of the factor effects is determined by:

$$\hat{\phi} = e^{\hat{\theta}} g_v \left[-\frac{v+1}{v} \frac{\hat{\sigma}_\theta^2}{2} \right] \tag{3}$$

(Bradu and Mundlak 1970)

where v are the degrees of freedom and $g_v(arg)$ can be approximated by e^{arg} for sufficiently large degrees of freedom (Ebbeler 1973).

An estimate of the variance of the factor effects is determined by:

$$e^{2\hat{\theta}}\left\{g_v^2\left[-\frac{v+1}{v}\frac{\hat{\sigma}_\theta^2}{2}\right]-g_v\left[-\frac{v+1}{v}2\hat{\sigma}_\theta^2\right]\right\}$$ (Bradu and Mundlak 1970)   (4)

Gavaris et al. (2007) derived a conversion factor of 1.2 with a standard error of 0.05 (FT hour = 1.2 ± 0.05 WF hour) for standardizing WF hours to FT hours and this conversion factor was applied to all effort data in hours from 2005 to 2011 to calculate discards in standardized freezer trawler hours. To determine if there has been any significant change in this conversion factor, the model from equation 2 was used to derive a conversion factor for standardizing effort in hours using data from January 2004 to December 2011.

If the main difference between WF and FT catch rates is the number of dredges and width of dredges, then it is expected that the use of effort in hours×meters should result in equivalent catch rates between these fleet types. To test this hypothesis, the multiplicative model from equation 2 was used to determine if a conversion factor was required for standardizing effort in hours×meters using data from January 2004 to December 2011.

RESULTS AND DISCUSSION

The main effects model for scallop catch rate in kg•h^{-1} accounted for 76% of the total variation and fit the data well (Figure 3). The model and analysis of variance results indicated that fleet was the dominant effect, followed by NAFO area, year, and month (Tables 2, 3). The conversion factor derived from wet fish hours to freezer trawler hours using data from January 2005 to December 2011 was estimated as 1.26 with a standard error of 0.05, which is consistent with the conversion factor of 1.2 with a standard error of 0.05 that Gavaris et al. (2007) derived using data from January 2004 to September 2006.

The main effects model for scallop catch rate in kg•hm^{-1} accounted for 75% of the total variation and fit the data well (Figure 4). However in contrast to the model for catch rate in kg•h^{-1}, the model and analysis of variance results using catch rate in kg•hm^{-1} indicated that fleet was not a factor whereas NAFO area, year, and month all had significant effects (Tables 4, 5). Therefore, when using effort in units of hm, a conversion factor between WF and FT hours is not required.

Both temporal and spatial patterns in discards may be expected and there was enough data from the fishery statistics from 2005 to 2011 to determine that scallop catch rates varied by NAFO area regardless of whether effort was in hours or hour×meters (Tables 2 to 5). However, there was not enough data from observed trips from 2005 to 2011 to calculate discards rates by area as unit area 5Zem has relatively limited coverage compared with 5Zej (Van Eeckhaute and Gavaris 2006; Gavaris et al. 2007, 2008, 2009; Van Eeckhaute et al. 2010, 2011). However, seasonal patterns in discards rates were smoothed by applying a 3-month moving window (Gavaris et al. 2007). Due to the difference in scale between discards rates in the units kg•h^{-1} and kg•hm^{-1}, a direct comparison is only possible for the trend. Standardized discard rates for yellowtail flounder, cod, and haddock are shown in Figures 5 to 7. For all three species, there was good correspondence between the pattern in discard rates between kg•h^{-1} and kg•hm^{-1} (Figures 5 to7). The most pronounced and consistent temporal trend in discard rate was observed for yellowtail flounder with higher discard rates occurring in the spring and early summer (Figure 5). However, the relative magnitude of this seasonal pattern in discard rate has been less pronounced since 2007 and is likely due to the introduction of scallop fishery area/time closures to reduce yellowtail flounder bycatch applied yearly each June (e.g. DFO 2012).

Total annual estimates of yearly discards calculated from discard rates in kg•h^{-1} (Table 6) and kg•hm^{-1} (Table 7) from 2005 to 2011 were relatively similar for all three species, with a maximum difference of 21 mt occurring for yellowtail flounder in 2006 (Tables 6, 7). It is

recommended that hours×metres be used as the measure of scallop fishing effort to calculate discards from the 2012 scallop fishery and for subsequent years.

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Table 1. Observed trips from the Canadian Georges Bank scallop fishery from 2005 to 2011. Effort in hours are standardized to freezer trawler hour equivalents whereas effort in hour×meters are presented without standardization.

| | | | | Proration | | | Discards (kg) | | | | | | | |
| | | | | Dredges | | | Yellowtail Flounder | | Cod | | Haddock | | Effort | Effort |
Year	Trip ID	Board Date	Land Date	Obs.	Total	Prop.	Observed	Prorated	Observed	Prorated	Observed	Prorated	(h)	(hm)
2005	T2005-1	2005-01-11	2005-01-16	134	226	0.59	311[1]	525	302	509	223	376	56	608
	T2005-2	2005-02-24	2005-03-09	359	679	0.53	359[1]	679	355	671	92	174	169	1749
	T2005-3	2005-03-16	2005-03-28	536	776	0.69	703	1018	172	249	307	444	169[2]	1856
	T2005-4	2005-05-13	2005-05-23	238	466	0.51	1125	2203	387	758	60	117	131	1436
	T2005-5	2005-06-20	2005-07-13	1156	1511	0.77	9273	12121	720	941	738	965	340	3533
	T2005-6	2005-06-30	2005-07-14	414	520	0.80	1053	1323	279	350	349	438	121	1249
	T2005-7	2005-07-28	2005-08-11	434	842	0.52	199	386	307	596	106	206	228	2366
	T2005-8	2005-09-19	2005-09-29	376	488	0.77	549	713	49	64	109	141	138	1510
	T2005-9	2005-10-18	2005-10-24	172	347	0.50	75	151	232	468	160	323	65	796
	T2005-10	2005-11-10	2005-11-24			0.59[3]	70	119	296	504	138	235	224	2316
	T2005-11	2005-12-06	2005-12-16	320	620	0.52	272	527	369	715	106	205	146	1516
2006	T2006-1	2006-02-07	2006-02-10	57	81	0.70	50	71	167	237	80	114	23	246
	T2006-2	2006-03-06	2006-03-15	394	584	0.67	653	968	210	311	137	203	100	1024
	T2006-3	2006-04-04	2006-04-20	308	586	0.53	1233	2346	1751	3331	218	415	147	1518
	T2006-4	2006-05-16	2006-05-24	202	305	0.66	1762	2660	117	177	26	39	67	732
	T2006-5	2006-06-09	2006-06-27	655	1258	0.52	12215	23460	399	766	404	776	287	3952
	T2006-6	2006-07-13	2006-08-08	1011	1353	0.75	2968	3972	326	436	468	626	331	3427
	T2006-7	2006-08-11	2006-08-25	384	774	0.50	311	627	248	500	236	476	194	2000
	T2006-8	2006-10-03	2006-10-13	280	574	0.49	269	551	187	383	90	185	154	1692
	T2006-9	2006-10-23	2006-11-07	434	788	0.55	657	1193	36	65	16	29	230	2801
	T2006-10	2006-11-20	2006-12-01	280	451	0.62	130	209	170	274	172	277	136	1495
	T2006-11	2006-12-01	2006-12-23	684	1365	0.50	313	625	936	1868	581	1159	359	3729
2007	T2007-1	2007-01-02	2007-01-11	190	388	0.49	3	6	414	845	55	112	109	1322
	T2007-2	2007-02-15	2007-03-02	287	556	0.52	7	14	1277	2474	303	587	136	1656
	T2007-3	2007-03-15	2007-04-02	266	516	0.52	122	237	495	960	157	305	89	815
	T2007-4	2007-03-27	2007-04-17	466	954	0.49	1628	3333	1685	3450	736	1507	177	1837
	T2007-5	2007-05-01	2007-05-10	145	255	0.57	174	306	94	165	28	49	31	335
	T2007-6	2007-06-14	2007-06-29	389	751	0.52	97	187	120	232	57	110	91	1117

| | | | | Proration | | | Discards (kg) | | | | | | Effort | Effort |
| | | | | Dredges | | | Yellowtail Flounder | | Cod | | Haddock | | | |
Year	Trip ID	Board Date	Land Date	Obs.	Total	Prop.	Observed	Prorated	Observed	Prorated	Observed	Prorated	(h)	(hm)
	T2007-7	2007-07-11	2007-08-03	657	1176	0.56	1185	2121	493	882	1057	1892	223	2310
	T2007-8	2007-07-23	2007-07-31	140	226	0.62	28	45	12	19	5	8	27	290
	T2007-9	2007-08-06	2007-08-21	554	1080	0.51	67	131	18	35	20	39	180	1875
	T2007-10	2007-08-10	2007-08-25	492	1002	0.49	186	379	71	145	44	90	194	2010
	T2007-11	2007-08-28	2007-09-06	316	504	0.63	627	1000	201	321	137	219	103	1058
	T2007-12	2007-09-21	2007-09-30	202	374	0.54	33	61	93	172	45	83	80	878
	T2007-13	2007-10-09	2007-10-18	204	400	0.51	5	10	17	33	11	22	80	881
	T2007-14	2007-10-11	2007-10-18	210	408	0.51	44	85	32	62	56	109	45	488
2008	T2008-1	2008-01-02	2008-01-24	618	1254	0.49	14	28	400	812	259	526	239	2478
	T2008-2	2008-01-18	2008-01-29	226	421	0.54	0	0	63	117	31	58	75	779
	T2008-3	2008-02-24	2008-03-04	190	358	0.53	6	11	98	185	102	192	77	839
	T2008-4	2008-02-23	2008-03-10	648	1320	0.49	5	10	27	55	12	24	194	2023
	T2008-5	2008-03-10	2008-03-15	58	116	0.50	27	54	96	192	53	106	25	267
	T2008-6	2008-03-23	2008-04-02	230	432	0.53	50	94	87	163	70	131	95	1042
	T2008-7	2008-04-09	2008-04-21	410	810	0.51	2031	4012	199	393	292	577	163	1656
	T2008-8	2008-04-09	2008-04-24	374	844	0.44	45	102	62	140	12	27	194	2012
	T2008-9	2008-05-14	2008-05-23	138	252	0.55	250	457	61	111	2	4	40	434
	T2008-10	2008-05-31	2008-06-19	546	1078	0.51	464	916	10	20	7	14	217	2261
	T2008-11	2008-06-25	2008-07-09	432	827	0.52	232	444	72	138	46	88	138	1436
	T2008-13	2008-07-15	2008-07-29	361	721	0.50	62	124	14	28	13	26	133	1374
	T2008-12	2008-07-09	2008-07-17	112	182	0.62	246	400	19	31	23	37	27	293
	T2008-14	2008-08-02	2008-08-25	398	806	0.49	601	1217	208	421	312	632	337	3504
	T2008-15	2008-08-23	2008-09-06	510	940	0.54	6	11	0	0	1	2	190	1968
	T2008-16	2008-09-15	2008-09-24	196	366	0.54	226	421	76	141	41	77	90	986
	T2008-17	2008-09-21	2008-09-26	168	266	0.63	79	125	11	17	5	8	58	628
	T2008-18	2008-09-30	2008-10-09	290	468	0.62	27	44	18	29	16	26	101	1106
	T2008-19	2008-10-07	2008-10-28	589	1145	0.51	216	420	127	247	164	319	217	2632
	T2008-20	2008-11-07	2008-11-22	637	1265	0.50	48	95	49	97	40	79	225	2271
	T2008-21	2008-11-13	2008-11-28	549	1040	0.53	154	292	218	413	165	313	211	2193
	T2008-22	2008-12-06	2008-12-22	538	1089	0.49	24	49	125	253	148	300	225	2326
	T2008-23	2008-12-14	2008-12-20	202	364	0.55	14	25	10	18	9	16	56	603

| | | | | Proration | | | Discards (kg) | | | | | | Effort | Effort |
| | | | | Dredges | | | Yellowtail Flounder | | Cod | | Haddock | | | |
Year	Trip ID	Board Date	Land Date	Obs.	Total	Prop.	Observed	Prorated	Observed	Prorated	Observed	Prorated	(h)	(hm)
2009	T2009-01	2009-01-02	2009-01-23	384	804	0.48	57	119	268	561	430	900	290	2943
	T2009-02	2009-01-16	2009-01-29	463	855	0.54	13	24	171	316	206	380	170	1757
	T2009-03	2009-02-18	2009-03-06	614	1252	0.49	246	502	244	498	162	330	212	2775
	T2009-04	2009-02-19	2009-03-03	320	624	0.51	25	49	170	332	29	57	112	1157
	T2009-05	2009-03-10	2009-03-20	366	686	0.53	117	219	45	84	64	120	118	1294
	T2009-06	2009-03-27	2009-04-14	810	1320	0.61	632	1030	208	339	666	1085	279	2893
	T2009-07	2009-04-14	2009-04-24	92	178	0.52	31	60	11	21	8	15	19	213
	T2009-08	2009-04-16	2009-05-01	306	594	0.52	145	281	323	627	174	338	129	1336
	T2009-09	2009-05-06	2009-05-15	390	590	0.66	116	175	21	32	27	41	68	741
	T2009-10	2009-05-16	2009-05-31	495	990	0.50	769	1538	235	470	84	168	183	1883
	T2009-11	2009-06-15	2009-06-24	114	204	0.56	4	7	6	11	0	0	10	106
	T2009-12	2009-06-16	2009-07-01	292	518	0.56	73	130	46	82	12	21	79	815
	T2009-13	2009-07-09	2009-07-24	431	745	0.58	12	21	170	294	67	116	129	1337
	T2009-14	2009-07-14	2009-07-23	125	272	0.46	23	50	108	235	27	59	56	613
	T2009-15	2009-07-31	2009-08-15	467	937	0.50	119	239	49	98	125	251	193	1959
	T2009-16	2009-08-17	2009-08-22	232	392	0.59	101	171	7	12	8	14	62	632
	T2009-17	2009-09-08	2009-09-18	360	594	0.61	143	236	81	134	46	76	117	1279
	T2009-18	2009-09-16	2009-10-01	504	950	0.53	370	697	298	562	90	170	212	2195
	T2009-19	2009-09-30	2009-10-20	682	1386	0.49	1208	2455	776	1577	644	1309	276	2859
	T2009-20	2009-10-17	2009-11-01	510	1097	0.46	33	71	92	198	49	105	192	1989
	T2009-21	2009-11-14	2009-12-01	640	1100	0.58	72	124	349	600	132	227	277	2875
	T2009-22	2009-11-15	2009-12-02	469	954	0.49	64	130	146	297	53	108	249	2273
2010	T2010-01	2010-01-04	2010-01-20	462	950	0.49	76	156	416	855	158	325	197	2389
	T2010-02	2010-01-20	2010-02-06	624	1244	0.50	49	98	164	327	29	58	229	2079
	T2010-03	2010-02-06	2010-02-21	547	1101	0.50	23	46	62	125	10	20	209	1908
	T2010-04	2010-03-08	2010-03-13	80	156	0.51	31	60	38	74	10	20	44	483
	T2010-05	2010-03-08	2010-03-29	787	1617	0.49	531	1091	1011	2077	189	388	292	3025
	T2010-06	2010-03-14	2010-03-29	605	1228	0.49	292	593	69	140	23	47	238	2132
	T2010-07	2010-04-06	2010-04-16	340	418	0.81	112	138	43	53	21	26	72	783
	T2010-08	2010-04-13	2010-04-28	534	1124	0.48	761	1602	85	179	39	82	229	2098

| Year | Trip ID | Board Date | Land Date | Proration Dredges | | | Discards (kg) Yellowtail Flounder | | Cod | | Haddock | | Effort | Effort |
				Obs.	Total	Prop.	Observed	Prorated	Observed	Prorated	Observed	Prorated	(h)	(hm)
	T2010-09	2010-05-19	2010-06-02	346	750	0.46	290	629	69	150	39	85	160	1659
	T2010-10	2010-05-25	2010-06-04	300	538	0.56	5111	9166	91	163	3	5	126	1290
	T2010-11	2010-06-03	2010-06-18	405	828	0.49	286	585	129	264	20	41	134	1229
	T2010-12	2010-06-25	2010-07-16	596	1224	0.49	491	1008	89	183	31	64	200	2074
	T2010-13	2010-07-18	2010-08-02	473	916	0.52	568	1100	56	108	37	72	164	1496
	T2010-14	2010-07-23	2010-08-02	233	441	0.53	136	257	36	68	22	42	68	742
	T2010-15	2010-08-16	2010-08-31	582	1189	0.49	459	938	96	196	27	55	179	1641
	T2010-16	2010-08-31	2010-09-15	531	1030	0.52	56	109	9	17	6	12	171	1777
	T2010-17	2010-09-07	2010-09-16	201	360	0.56	69	124	90	161	17	30	93	1016
	T2010-18	2010-09-30	2010-10-15	253	498	0.51	35	69	0	0	34	67	236	2160
	T2010-19	2010-10-11	2010-10-15	93	147	0.63	45	71	1	2	22	35	30	332
	T2010-20	2010-10-19	2010-10-29	280	420	0.67	17	26	6	9	18	27	99	1089
	T2010-21	2010-11-05	2010-11-21	558	1093	0.51	109	214	156	306	77	151	233	2417
	T2010-22	2010-11-14	2010-11-24	352	620	0.57	10	18	14	25	4	7	126	1381
	T2010-23	2010-12-02	2010-12-12	220	372	0.59	5	8	16	27	2	3	65	709
	T2010-24	2010-12-07	2010-12-23	544	1046	0.52	42	81	82	158	42	81	232	2408
2011	T2011-01	2011-01-18	2011-02-06	507	1061	0.48	22	46	174	364	80	167	212	1934
	T2011-02	2011-01-20	2011-02-06	651	1342	0.49	91	188	436	899	154	317	275	3700
	T2011-03	2011-02-06	2011-02-21	480	954	0.50	6	12	60	119	54	107	199	1817
	T2011-04	2011-03-30	2011-04-20	648	1222	0.53	60	113	112	211	10	19	179	1852
	T2011-05	2011-04-07	2011-04-17	140	280	0.50	160	320	86	172	75	150	42	458
	T2011-06	2011-04-17	2011-05-02	312	664	0.47	114	243	378	804	57	121	130	1164
	T2011-07	2011-05-06	2011-05-16	246	322	0.76	21	27	36	47	0	0	46	506
	T2011-08	2011-05-17	2011-06-01	330	716	0.46	650	1410	95	206	18	39	152	1388
	T2011-09	2011-06-12	2011-06-23	209	417	0.50	76	152	15	30	7	14	65	717
	T2011-10	2011-06-17	2011-07-02	442	918	0.48	246	511	102	212	47	98	171	1565
	T2011-11	2011-07-14	2011-07-29	523	1099	0.48	277	582	30	63	24	50	221	2024
	T2011-12	2011-07-25	2011-08-04	271	425	0.64	24	38	7	11	9	14	88	956
	T2011-13	2011-08-12	2011-08-23	352	694	0.51	117	231	64	126	18	35	137	1391
	T2011-14	2011-08-19	2011-09-03	592	1226	0.48	301	623	116	240	66	137	196	1790
	T2011-15	2011-09-16	2011-09-24	193	367	0.53	112	213	8	15	48	91	103	1121

| Year | Trip ID | Board Date | Land Date | Proration | | | Discards (kg) | | | | | | Effort | Effort |
| | | | | Dredges | | | Yellowtail Flounder | | Cod | | Haddock | | | |
				Obs.	Total	Prop.	Observed	Prorated	Observed	Prorated	Observed	Prorated	(h)	(hm)
	T2011-16	2011-09-23	2011-10-08	528	1180	0.45	54	121	26	58	22	49	204	1869
	T2011-17	2011-10-18	2011-10-24	197	389	0.51	79	156	46	91	39	77	76	701
	T2011-18	2011-10-21	2011-11-05	700	1350	0.52	65	125	67	129	141	272	189	1676
	T2011-19	2011-11-20	2011-12-05	708	1320	0.54	21	39	139	259	91	170	201	1841
	T2011-20	2011-11-22	2011-12-07	583	1128	0.52	44	85	170	329	36	70	233	2130
	T2011-21	2011-12-05	2011-12-20	588	1188	0.49	27	55	142	287	106	214	217	1897
	T2011-22	2011-12-07	2011-12-22	641	1277	0.50	5	10	182	363	148	295	235	2146

[1]Not used because of species identification error.
[2]Effort derived from average hours per dredge.
[3]Proration factor based on ratio of observed to total scallop catch.

Table 2. Results of fitting a linear model to log transformed scallop catch rates in kg•h^{-1} for the offshore scallop fishery on Georges Bank.

Coefficients	Estimate	Std Error	T value	Prob(>|t|)
Intercept	4.264	0.083	51.294	< 0.001*
Fleet FT	0.230	0.030	7.785	< 0.001*
Month 2	0.099	0.102	0.972	0.332
Month 3	0.159	0.096	1.653	0.100
Month 4	0.544	0.091	5.994	< 0.001*
Month 5	0.562	0.093	6.073	< 0.001*
Month 6	0.525	0.092	5.706	< 0.001*
Month 7	0.555	0.092	6.032	< 0.001*
Month 8	0.344	0.091	3.790	< 0.001*
Month 9	0.210	0.090	2.338	0.020*
Month 10	0.087	0.091	0.962	0.337
Month 11	0.007	0.091	0.080	0.936
Month 12	-0.034	0.097	-0.347	0.729
Year 2006	0.176	0.052	3.360	0.001*
Year 2007	0.785	0.063	12.503	< 0.001*
Year 2008	0.421	0.057	7.444	< 0.001*
Year 2009	0.377	0.050	7.487	< 0.001*
Year 2010	0.250	0.052	4.777	< 0.001*
Year 2011	0.331	0.052	6.406	< 0.001*
NAFO 5Zem	-0.260	0.035	-7.419	< 0.001*

* significant at $p < 0.05$

Table 3. Analysis of variance from the multiplicative model analysis of wet fish and freezer trawler scallop catch rates (kg•h^{-1}) from the Canadian scallop fishery on Georges Bank with effort in unstandardized hours.

Source	df	Sums of Squares	Mean Square	F Value	Prob>F
Fleet	1	2.753	2.753	60.604	< 0.001*
Month	11	14.460	1.315	28.939	< 0.001*
Year	6	10.549	1.758	38.704	< 0.001*
NAFO area	1	2.500	2.500	55.043	< 0.001*
Residuals	188	8.540	0.045		

* significant at $p < 0.05$

Table 4. Results of fitting a linear model to log transformed scallop catch rates in kg•hm^{-1} for the offshore scallop fishery on Georges Bank.

Coefficients	Estimate	Std Error	T value	Prob(>|t|)
Intercept	2.036	0.085	23.999	< 0.001*
Fleet FT	0.050	0.030	1.674	0.096
Month 2	0.123	0.104	1.183	0.238
Month 3	0.185	0.098	1.885	0.061
Month 4	0.553	0.093	5.971	< 0.001*
Month 5	0.591	0.094	6.255	< 0.001*
Month 6	0.553	0.094	5.885	< 0.001*
Month 7	0.584	0.094	6.220	< 0.001*
Month 8	0.354	0.093	3.822	< 0.001*
Month 9	0.246	0.092	2.687	0.008*
Month 10	0.118	0.093	1.272	0.205
Month 11	0.030	0.093	0.320	0.750
Month 12	0.004	0.099	0.037	0.970
Year 2006	0.168	0.053	3.144	0.002*
Year 2007	0.804	0.064	12.545	< 0.001*
Year 2008	0.455	0.058	7.885	< 0.001*
Year 2009	0.402	0.051	7.829	< 0.001*
Year 2010	0.285	0.053	5.334	< 0.001*
Year 2011	0.407	0.053	7.726	< 0.001*
NAFO 5Zem	-0.319	0.036	-8.929	< 0.001*

* significant at $p < 0.05$

Table 5. Analysis of variance from the multiplicative model analysis of wet fish and freezer trawler scallop catch rates (kg•hm^{-1}) from the Canadian scallop fishery on Georges Bank with effort in unstandardized hours×meters.

Source	df	Sums of Squares	Mean Square	F Value	Prob>F
Fleet	1	0.132	0.132	2.800	0.096
Month	11	14.896	1.354	28.625	< 0.001*
Year	6	11.997	1.999	42.264	< 0.001*
NAFO area	1	3.771	3.771	79.720	< 0.001*
Residuals	188	8.894	0.047		

* significant at $p < 0.05$

Table 6. Discards of cod, haddock and yellowtail flounder from the Canadian scallop fishery on Georges Bank for 2005 to 2011 calculated using a 3-month moving window discard rate with effort in hours standardized to freezer trawler hour equivalents.

Year	Month	Discard Rate (kg•h^{-1})			Effort	Discard (mt)			Cum Annual Discard (mt)		
		Yellowtail	Cod	Haddock	(h)	Yellowtail	Cod	Haddock	Yellowtail	Cod	Haddock
2005	Jan	5.353	5.252	2.447	150	1	1	0	1	1	0
	Feb	5.638	3.629	2.524	1002	6	4	3	6	4	3
	Mar	5.018	2.722	1.829	3039	15	8	6	22	13	8
	Apr	10.735	3.356	1.873	2965	32	10	6	54	23	14
	May	16.836	5.792	0.898	1255	21	7	1	75	30	15
	Jun	26.437	3.463	2.569	1608	43	6	4	117	35	19
	Jul	20.072	2.739	2.335	2073	42	6	5	159	41	24
	Aug	17.577	2.358	2.115	3290	58	8	7	217	49	31
	Sep	2.898	2.613	1.553	2973	9	8	5	225	57	36
	Oct	2.300	2.424	1.636	2762	6	7	5	232	63	40
	Nov	1.833	3.878	1.754	3542	6	14	6	238	77	46
	Dec	1.747	3.295	1.190	973	2	3	1	**240**	**80**	**48**
2006	Jan	3.158	10.547	5.053	767	2	8	4	2	8	4
	Feb	8.481	4.478	2.586	365	3	2	1	6	10	5
	Mar	12.560	14.397	2.714	120	2	2	0	7	11	5
	Apr	19.046	12.177	2.095	2268	43	28	5	50	39	10
	May	56.857	8.537	2.457	2586	147	22	6	197	61	16
	Jun	43.952	2.015	2.105	2191	96	4	5	294	66	21
	Jul	34.556	2.097	2.313	2960	102	6	7	396	72	28
	Aug	8.760	1.783	2.099	3336	29	6	7	425	78	35
	Sep	3.384	2.537	1.896	3148	11	8	6	436	86	41
	Oct	3.757	1.389	0.943	4258	16	6	4	452	92	45
	Nov	2.933	2.947	1.877	4707	14	14	9	466	105	54
	Dec	2.796	3.045	2.022	2562	7	8	5	**473**	**113**	**59**
2007	Jan	0.080	13.548	2.854	1169	0	16	3	0	16	3
	Feb	0.768	12.813	3.006	1105	1	14	3	1	30	7
	Mar	8.913	17.124	5.966	731	7	13	4	7	43	11
	Apr	13.056	15.413	6.268	1852	24	29	12	32	71	23
	May	12.804	12.872	5.575	2437	31	31	14	63	102	36
	Jun	7.159	3.496	5.543	1333	10	5	7	72	107	44
	Jul	4.006	1.837	2.993	1924	8	4	6	80	111	49
	Aug	4.630	1.951	2.888	2590	12	5	7	92	116	57
	Sep	2.441	1.125	0.822	1020	2	1	1	95	117	58
	Oct	3.750	1.908	1.402	331	1	1	0	**96**	**117**	**58**
	Nov										
	Dec										
2008	Jan	0.102	2.851	1.985	1390	0	4	3	0	4	3
	Feb	0.281	2.163	1.472	2039	1	4	3	1	8	6
	Mar	5.733	1.510	1.416	3050	17	5	4	18	13	10
	Apr	6.655	1.485	1.224	3536	24	5	4	42	18	14
	May	8.943	1.083	1.013	3133	28	3	3	70	22	18
	Jun	4.219	0.591	0.304	2656	11	2	1	81	23	18
	Jul	2.987	0.612	0.767	2898	9	2	2	90	25	21
	Aug	2.821	0.799	0.894	3619	10	3	3	100	28	24

Year	Month	Discard Rate (kg•h⁻¹)			Effort	Discard (mt)			Cum Annual Discard (mt)		
		Yellowtail	Cod	Haddock	(h)	Yellowtail	Cod	Haddock	Yellowtail	Cod	Haddock
	Sep	2.255	0.862	1.071	2199	5	2	2	105	30	26
	Oct	1.550	1.048	0.911	2950	5	3	3	109	33	29
	Nov	0.893	1.022	1.017	2795	2	3	3	112	36	32
	Dec	0.643	1.090	0.987	1620	1	2	2	**113**	**37**	**33**
2009	Jan	0.885	2.176	2.127	2687	2	6	6	2	6	6
	Feb	1.012	1.984	1.981	2502	3	5	5	5	11	11
	Mar	2.462	2.186	2.237	3075	8	7	7	12	18	18
	Apr	4.151	1.977	2.220	2385	10	5	5	22	22	23
	May	4.202	2.063	2.177	2840	12	6	6	34	28	29
	Jun	3.664	2.142	0.772	2250	8	5	2	43	33	31
	Jul	1.167	1.384	0.871	3129	4	4	3	46	37	33
	Aug	1.840	1.737	0.891	3434	6	6	3	53	43	37
	Sep	3.680	2.454	1.830	3164	12	8	6	64	51	42
	Oct	2.807	2.546	1.508	3733	10	10	6	75	60	48
	Nov	2.797	2.688	1.759	3322	9	9	6	84	69	54
	Dec	0.483	1.705	0.636	37	0	0	0	**84**	**69**	**54**
2010	Jan	0.473	2.059	0.634	1514	1	3	1	1	3	1
	Feb	1.691	2.976	0.709	1831	3	5	1	4	9	2
	Mar	3.257	2.443	0.537	2480	8	6	1	12	15	4
	Apr	11.440	2.443	0.562	3771	43	9	2	55	24	6
	May	16.820	1.122	0.331	3491	59	4	1	114	28	7
	Jun	14.970	1.099	0.362	2984	45	3	1	158	31	8
	Jul	5.223	1.100	0.367	3465	18	4	1	177	35	9
	Aug	4.045	0.840	0.314	3366	14	3	1	190	38	10
	Sep	1.653	0.477	0.280	2938	5	1	1	195	39	11
	Oct	0.637	0.526	0.333	3394	2	2	1	197	41	12
	Nov	0.476	0.515	0.363	3165	2	2	1	199	42	13
	Dec	0.488	0.785	0.369	2224	1	2	1	**200**	**44**	**14**
2011	Jan	0.358	2.015	0.863	572	0	1	0	0	1	0
	Feb	0.291	1.697	0.790	1781	1	3	1	1	4	2
	Mar	0.934	1.905	0.674	827	1	2	1	1	6	2
	Apr	2.843	2.087	0.584	1204	3	3	1	5	8	3
	May	3.539	2.145	0.562	2671	9	6	2	14	14	5
	Jun	3.664	0.767	0.290	3351	12	3	1	27	17	6
	Jul	2.435	0.778	0.397	3615	9	3	1	35	19	7
	Aug	1.907	0.542	0.398	4027	8	2	2	43	22	9
	Sep	1.625	0.730	0.732	3022	5	2	2	48	24	11
	Oct	0.735	0.877	0.725	2034	1	2	1	50	26	12
	Nov	0.408	1.266	0.953	2010	1	3	2	50	28	14
	Dec	0.213	1.397	0.845	669	0	1	1	**51**	**29**	**15**

Table 7. Discards of cod, haddock and yellowtail flounder from the Canadian scallop fishery on Georges Bank for 2005 to 2011 calculated using a 3-month moving window discard rate with effort in hour×meters.

Year	Month	Discard Rate (kg•hm^{-1})			Effort	Discard (mt)			Cum Annual Discard (mt)		
		Yellowtail	Cod	Haddock	(hm)	Yellowtail	Cod	Haddock	Yellowtail	Cod	Haddock
2005	Jan	0.511	0.501	0.233	1762	1	1	0	1	1	0
	Feb	0.527	0.339	0.236	11350	6	4	3	7	5	3
	Mar	0.471	0.255	0.172	32806	15	8	6	22	13	9
	Apr	0.978	0.306	0.171	32493	32	10	6	54	23	14
	May	1.534	0.528	0.082	13452	21	7	1	75	30	15
	Jun	2.516	0.330	0.245	17208	43	6	4	118	36	20
	Jul	1.935	0.264	0.225	22747	44	6	5	162	42	25
	Aug	1.680	0.225	0.202	36472	61	8	7	223	50	32
	Sep	0.268	0.241	0.143	32038	9	8	5	232	58	37
	Oct	0.213	0.224	0.151	30567	7	7	5	238	65	41
	Nov	0.172	0.365	0.165	39128	7	14	6	245	79	48
	Dec	0.169	0.318	0.115	10679	2	3	1	**247**	**82**	**49**
2006	Jan	0.289	0.965	0.462	8007	2	8	4	2	8	4
	Feb	0.818	0.432	0.249	3870	3	2	1	5	9	5
	Mar	1.214	1.392	0.262	1241	2	2	0	7	11	5
	Apr	1.825	1.167	0.201	25895	47	30	5	54	41	10
	May	4.590	0.689	0.198	28325	130	20	6	184	61	16
	Jun	3.710	0.170	0.178	24344	90	4	4	275	65	20
	Jul	2.992	0.182	0.200	32832	98	6	7	373	71	27
	Aug	0.847	0.172	0.203	37140	31	6	8	404	77	34
	Sep	0.319	0.239	0.179	34587	11	8	6	415	86	40
	Oct	0.326	0.121	0.082	47687	16	6	4	431	91	44
	Nov	0.265	0.267	0.170	52207	14	14	9	445	105	53
	Dec	0.253	0.275	0.183	28763	7	8	5	**452**	**113**	**58**
2007	Jan	0.007	1.115	0.235	12859	0	14	3	0	14	3
	Feb	0.068	1.128	0.265	11924	1	13	3	1	28	6
	Mar	0.832	1.598	0.557	7549	6	12	4	7	40	10
	Apr	1.297	1.532	0.623	20024	26	31	12	33	71	23
	May	1.163	1.170	0.507	26463	31	31	13	64	101	36
	Jun	0.656	0.321	0.508	14508	10	5	7	73	106	44
	Jul	0.377	0.173	0.281	19984	8	3	6	81	110	49
	Aug	0.444	0.187	0.277	27025	12	5	7	93	115	57
	Sep	0.232	0.107	0.078	10908	3	1	1	96	116	58
	Oct	0.350	0.178	0.131	3627	1	1	0	**97**	**116**	**58**
	Nov										
	Dec										
2008	Jan	0.010	0.272	0.189	14048	0	4	3	0	4	3
	Feb	0.027	0.205	0.140	20641	1	4	3	1	8	6
	Mar	0.546	0.144	0.135	31886	17	5	4	18	13	10
	Apr	0.636	0.142	0.117	37149	24	5	4	42	18	14
	May	0.862	0.104	0.098	32161	28	3	3	69	21	17
	Jun	0.404	0.057	0.029	27963	11	2	1	81	23	18
	Jul	0.287	0.059	0.074	30336	9	2	2	89	25	20
	Aug	0.269	0.076	0.085	38569	10	3	3	100	28	24
	Sep	0.207	0.079	0.098	22712	5	2	2	105	29	26

| Year	Month	Discard Rate (kg•hm^{-1})			Effort	Discard (mt)			Cum Annual Discard (mt)		
		Yellowtail	Cod	Haddock	(hm)	Yellowtail	Cod	Haddock	Yellowtail	Cod	Haddock
	Oct	0.142	0.096	0.084	30852	4	3	3	109	32	28
	Nov	0.083	0.095	0.095	28743	2	3	3	111	35	31
	Dec	0.062	0.106	0.096	16362	1	2	2	**112**	**37**	**33**
2009	Jan	0.080	0.198	0.193	26917	2	5	5	2	5	5
	Feb	0.092	0.180	0.180	25309	2	5	5	4	10	10
	Mar	0.221	0.197	0.201	32500	7	6	7	12	16	16
	Apr	0.395	0.188	0.211	24792	10	5	5	21	21	22
	May	0.403	0.198	0.209	29043	12	6	6	33	27	28
	Jun	0.350	0.204	0.074	23086	8	5	2	41	31	29
	Jul	0.113	0.134	0.084	33828	4	5	3	45	36	32
	Aug	0.176	0.166	0.085	36918	7	6	3	52	42	35
	Sep	0.355	0.236	0.176	33092	12	8	6	63	50	41
	Oct	0.276	0.250	0.148	38902	11	10	6	74	60	47
	Nov	0.278	0.267	0.175	33988	9	9	6	84	69	53
	Dec	0.049	0.174	0.065	369	0	0	0	**84**	**69**	**53**
2010	Jan	0.047	0.205	0.063	15414	1	3	1	1	3	1
	Feb	0.170	0.299	0.071	18459	3	6	1	4	9	2
	Mar	0.338	0.254	0.056	25553	9	6	1	13	15	4
	Apr	1.158	0.247	0.057	39753	46	10	2	59	25	6
	May	1.717	0.115	0.034	35660	61	4	1	120	29	7
	Jun	1.501	0.110	0.036	31331	47	3	1	167	33	8
	Jul	0.541	0.114	0.038	36333	20	4	1	186	37	10
	Aug	0.404	0.084	0.031	34234	14	3	1	200	40	11
	Sep	0.167	0.048	0.028	30854	5	1	1	205	41	12
	Oct	0.062	0.051	0.032	34943	2	2	1	208	43	13
	Nov	0.046	0.050	0.035	32335	1	2	1	209	44	14
	Dec	0.046	0.074	0.035	22794	1	2	1	**210**	**46**	**15**
2011	Jan	0.033	0.186	0.079	6079	0	1	0	0	1	0
	Feb	0.028	0.162	0.075	17782	0	3	1	1	4	2
	Mar	0.098	0.201	0.071	8861	1	2	1	2	6	2
	Apr	0.296	0.217	0.061	11889	4	3	1	5	8	3
	May	0.363	0.220	0.058	26821	10	6	2	15	14	5
	Jun	0.380	0.080	0.030	34359	13	3	1	28	17	6
	Jul	0.253	0.081	0.041	36534	9	3	2	37	20	7
	Aug	0.198	0.056	0.041	41435	8	2	2	45	22	9
	Sep	0.172	0.077	0.077	30537	5	2	2	51	25	11
	Oct	0.079	0.094	0.078	20296	2	2	2	52	27	13
	Nov	0.045	0.140	0.106	20235	1	3	2	53	29	15
	Dec	0.024	0.154	0.093	6107	0	1	1	**53**	**30**	**16**
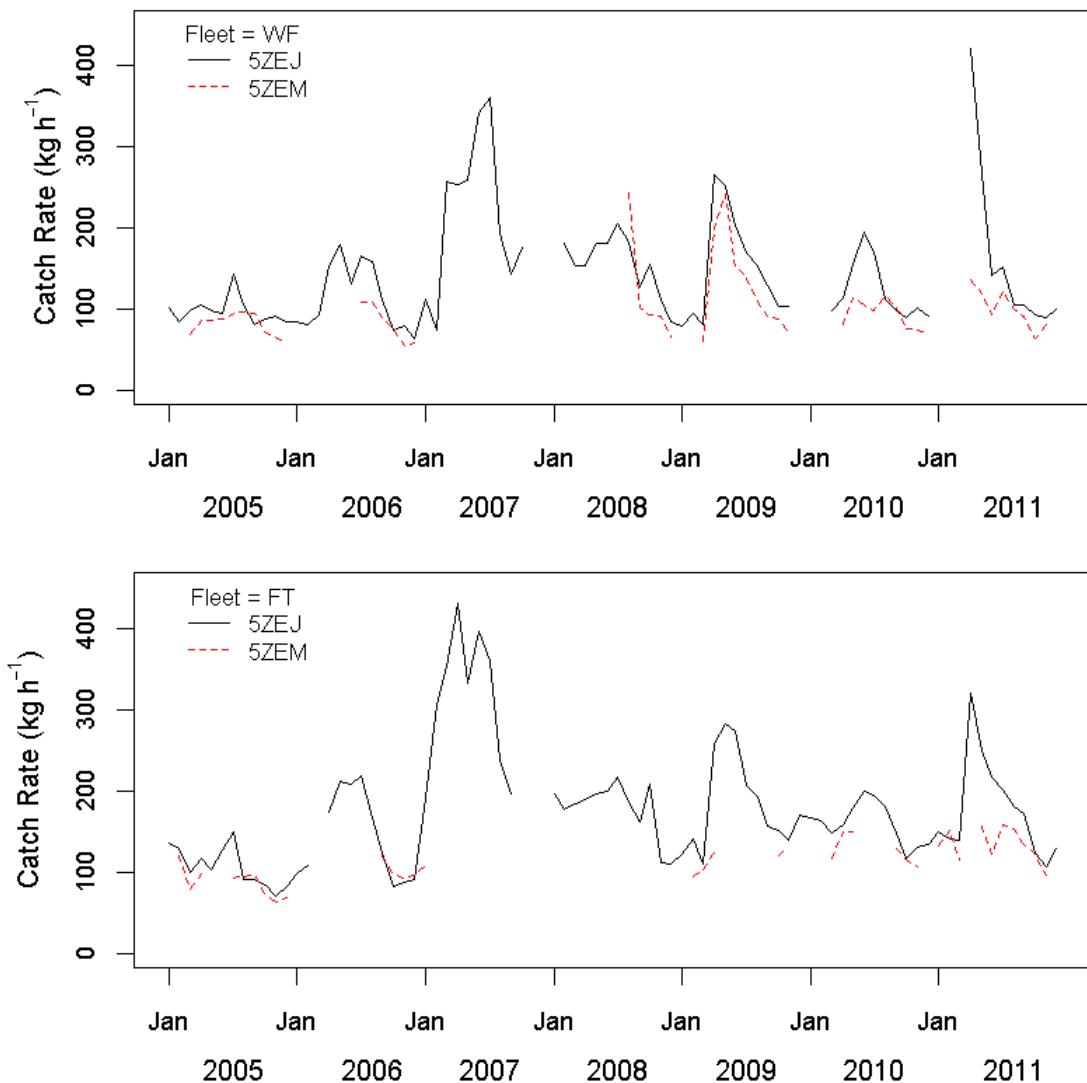
Figure 1. Scallop catch rates in kg•h^{-1} for wet fish (WF) and freezer trawlers (FT) by NAFO areas 5Zej and 5Zem from January 2005 to December 2011.
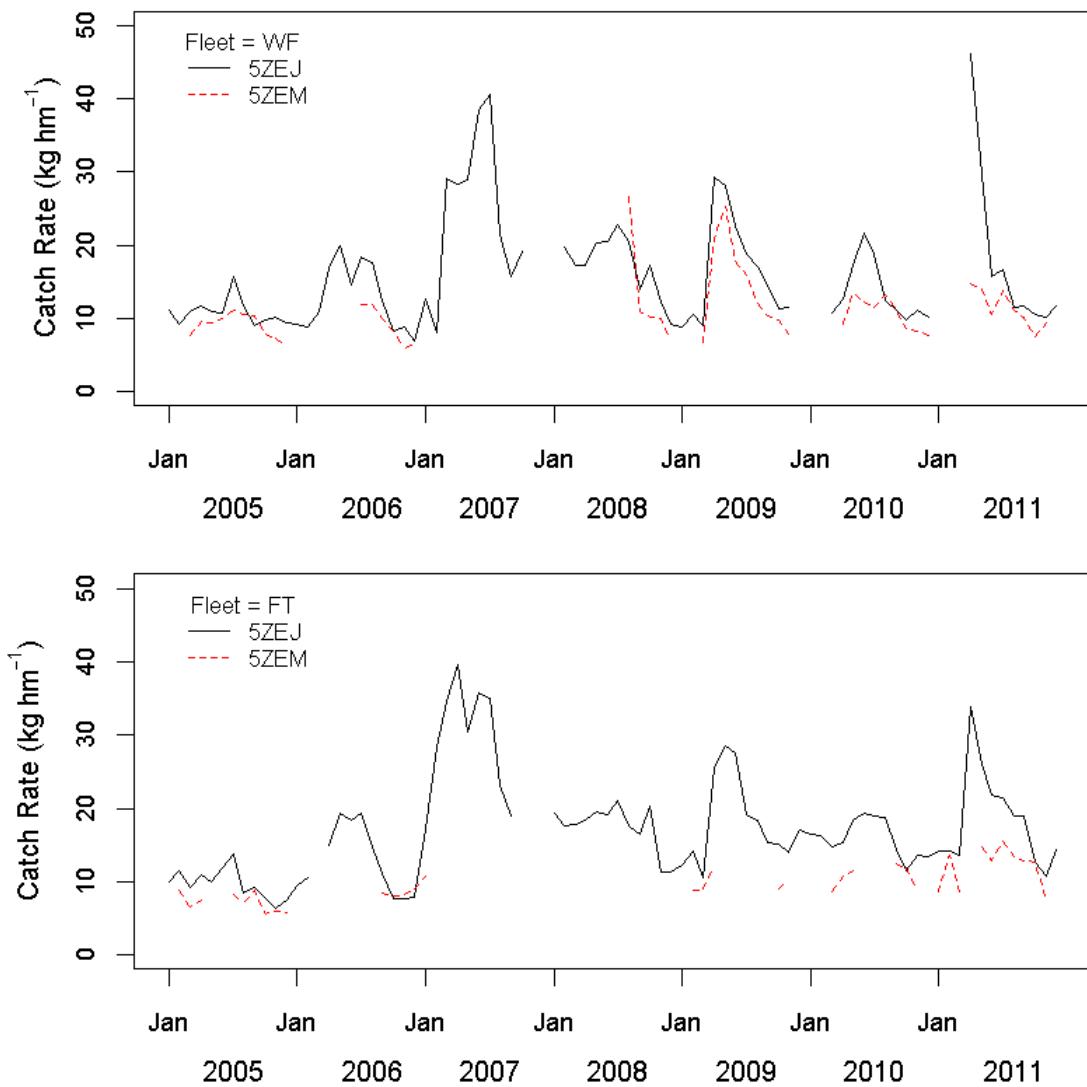
Figure 2. Scallop catch rates in kg•hm^{-1} for wet fish (WF) and freezer trawlers (FT) by NAFO areas 5Zej and 5Zem from January 2005 to December 2011.
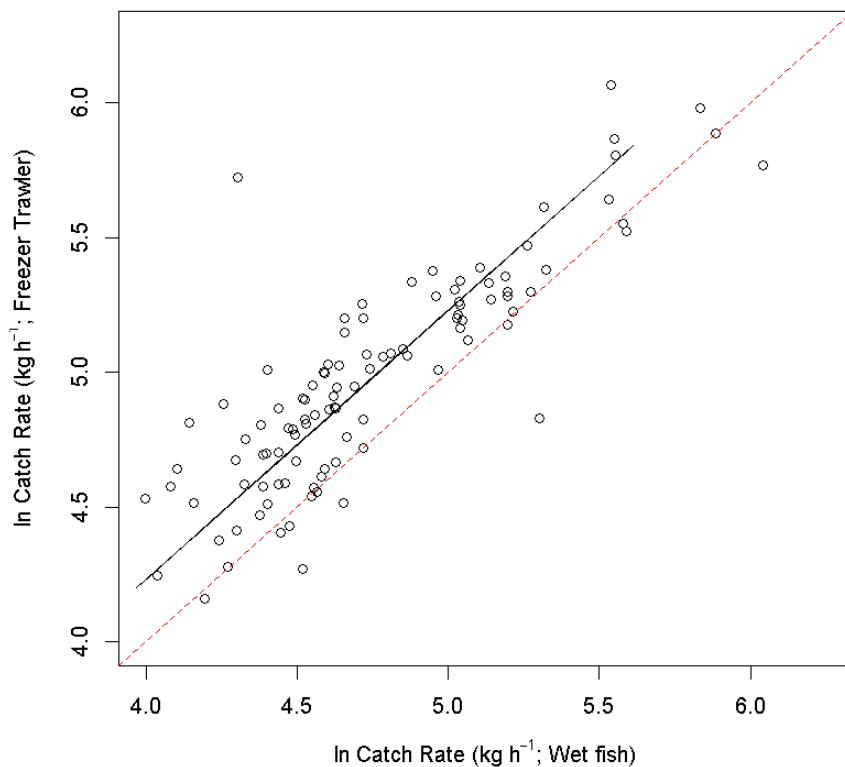
Figure 3. Log transformed scallop catch rates in kg•h^{-1} for freezer trawler and wet fish vessels from the Canadian scallop fishery on Georges Bank. The black line represents the predicted relationship from the multiplicative model. The red dashed line represents the 1 to 1 line.
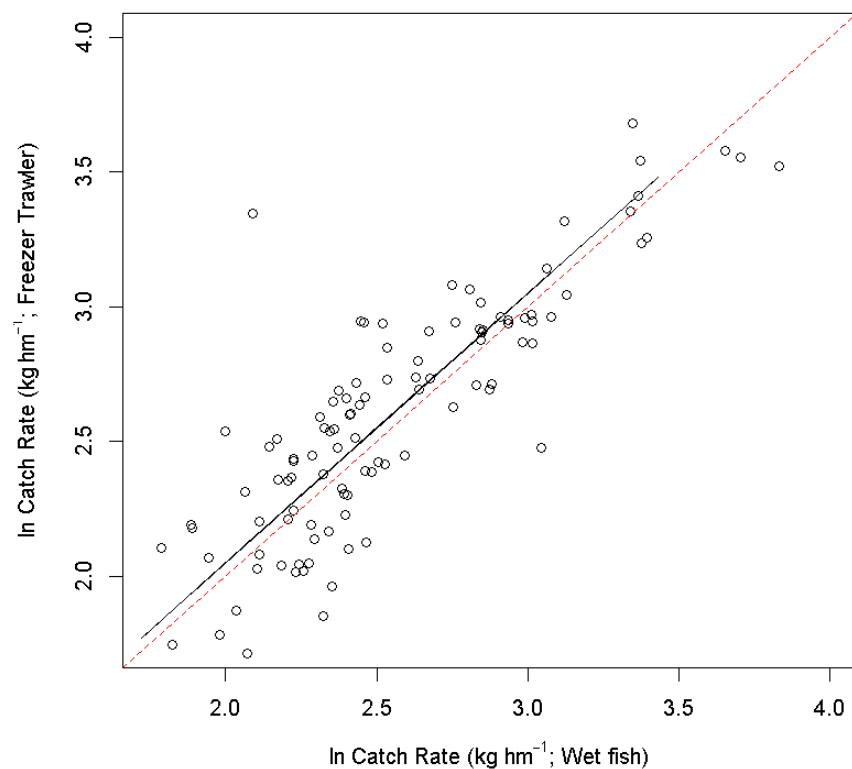
Figure 4. Log transformed scallop catch rates in kg•hm^{-1} for freezer trawler and wet fish vessels from the Canadian scallop fishery on Georges Bank. The black line represents the predicted relationship from the multiplicative model. The red dashed line represents the 1 to 1 line.
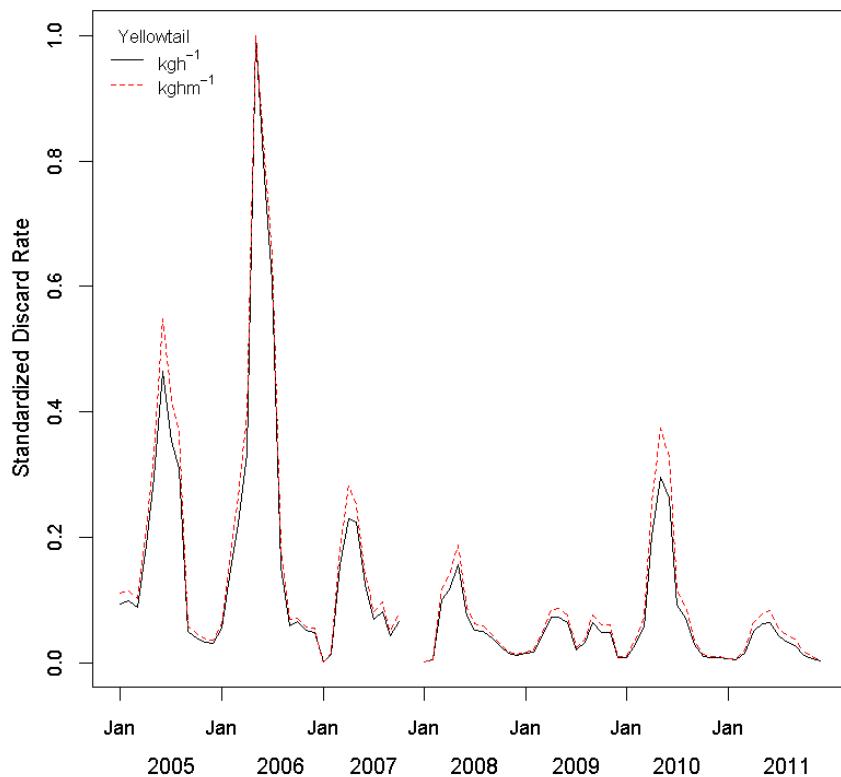
Figure 5. Temporal pattern of standardized discard rates (kg•h^{-1} and kg•hm^{-1}) for yellowtail flounder from January 2005 to December 2011. Note that the discard rate in kg•h^{-1} uses effort in standardized freezer trawler hours as per Gavaris et al. (2007).
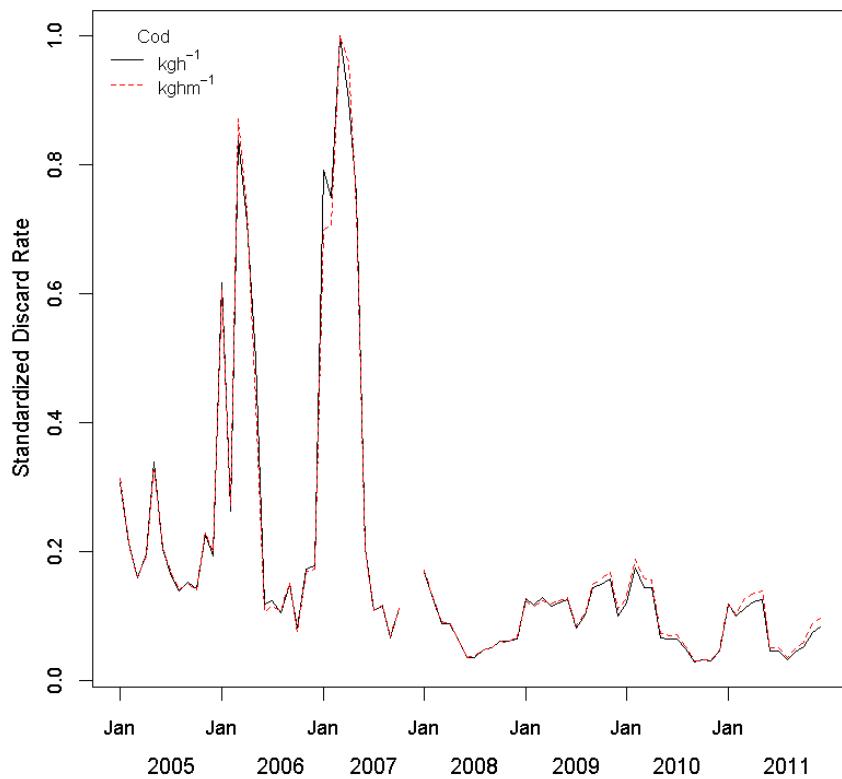
*Figure 6. Temporal pattern of standardized discard rates (kg•h^{-1} and kg•hm^{-1}) for Atlantic cod from January 2005 to December 2011. Note that the discard rate in kg•h^{-1} uses effort in standardized freezer trawler hours as per Gavaris et al. (2007).*
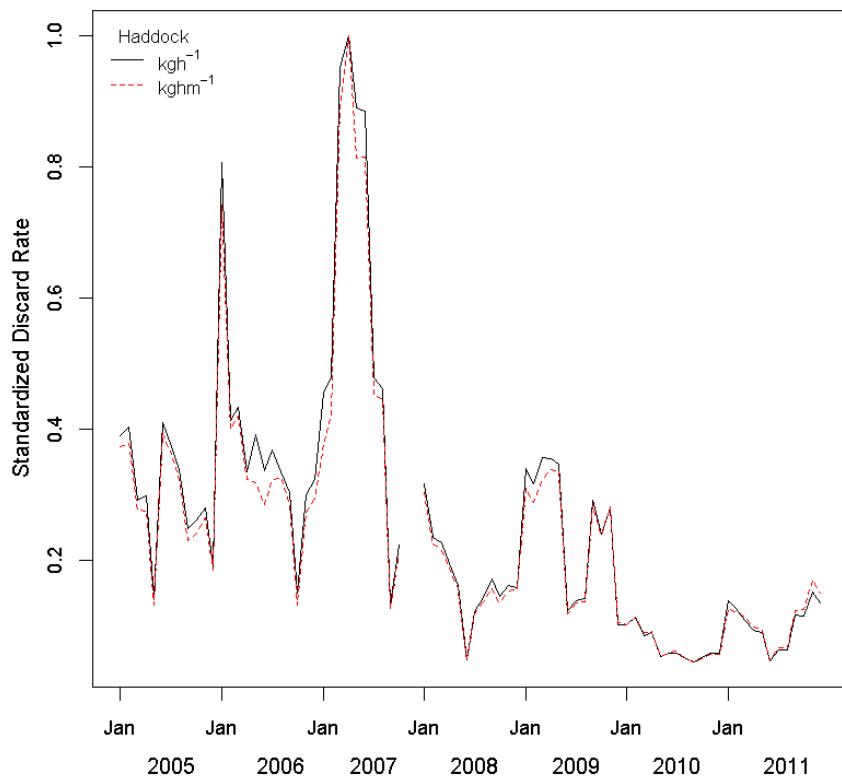
Figure 7. Temporal pattern of standardized discard rates (kg•h^{-1} and kg•hm^{-1}) for haddock from January 2005 to December 2011. Note that the discard rate in kg•h^{-1} uses effort in standardized freezer trawler hours as per Gavaris et al. (2007).