Skates:
Discard Estimations
Appendix 2

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Data Poor Stocks Working Group Meeting
Woods Hole, MA
December 8-12, 2008

This Working Paper was distributed for pre-dissemination peer review at the NE Data Poor Stocks Peer Review Meeting, December 8-12, 2008. It does not represent any final NOAA agency determination or policy. Some comments in the Peer Review Panel's Report of the Data Poor Stock Working Group are in response to this WP.

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John Pappalardo, *Chairman* | Paul J. Howard, *Executive Director*

MEMORANDUM

DATE: **December 11, 2008**

TO: Data Poor Assessment Workshop

FROM: Andrew Applegate

SUBJECT: **Discard estimation**

During the Data Poor Assessment Workshop (DPWS), new skate discard estimates were presented which differed substantially (see Figure 1) from those estimated during SAW44 and updated by the Skate PDT during the development of Amendment 3. Most of the differences were thought to be associated with filling unmatched trips with average DK (live weight ratio of observed discarded skates to the observed kept of all species). Like the SAW44 estimate, a three level stratification was applied to observed trips and dealer landings (obtained from the area allocation "AA" tables). The stratification included gear (longline, limited access scallop dredge, general category scallop dredge, shrimp trawl, sink gillnet, and fish trawl), region (Gulf of Maine, Georges Bank, Southern New England, Mid-Atlantic) and quarter (1-4).

The new estimates had the same trend as the previous ones through 2002, but differed substantially from 2003 to 2006 (Figure 1). Most filled DK rations, however, were concentrated in earlier years (Figures 4-7), the largest difference arising from longline gear in 1991 and 1992 and trawl gear in 1998. The cause of the differences for 2003-2006 were not apparent. These more recent discard estimates are critically important because the Council uses the last three years of the discard time series (2004-2006) to reduce the allowable catch limits and set landings targets. Based on the earlier estimates, it was believed that discards had declined substantially due to regulatory effects. The new estimated discards do not show this decline.

To explore the source of these important differences the sea sampling and dealer data were analyzed independently using a different stratification schema to potentially reduce the effects of oversampling of the US/CA area, access area, and special access program trips which are distributed in special areas. Also mesh categories were also introduced to account for DK differences that might be caused by small (< 5.5 inches), large (5.5 to 8 inches), and very large mesh (> 8 inches) for trawl and sink gillnets. A seasonal stratification was also applied (fall 07-10, spring 03-06, and winter 11-02) to comport with the three annual finfish NMFS trawl surveys so that the aggregate discard estimates could be allocated by species. A four level stratification was applied to both data sets: gear (longline, scallop dredge, scallop trawl, sink gillnet, fish trawl, shrimp trawl, and other), sub-region (Delmarva, E. Georges Bank, E. Gulf of Maine, NY Bight, Offshore, S. Channel, Southern New England, and Other), season (see above), and mesh

(see above). Dealer data that matched observed DK ratios from observed trips accounted for about 65-75% of total landings. Where DK matches did not exist, the DK ratio for a two level stratification (gear and sub-region) was applied. Together, the combined matches accounted for 95-99% of total landings. The remaining unmatched trips were for combinations that generally seemed to be associated with low skate discards and the DK ratios were assumed to be zero. No general linear modeling was applied (see analysis below for further discussion) at the time of these discard estimates.

Similar to the NEFSC estimates, the ratio of sums (DK) were applied to total live weight landings of all species on the dealer reports. A simplified method was also applied which discards are the multiplicative product of the observed skate discards per trip times the number of trips landed by dealers. For both, discard 95% confidence levels were computed by bootstrapping the trips (10% of trips in 100 iterations) to obtain a standard deviation for the DK mean by gear. The discard estimates in each 'cell' were then calculated over 1000 iterations with a log normal distribution on DK with a mean μ and a standard deviation σ.

The alternative discard estimates (Figure 2) tend to agree reasonably well with the NEFSC estimates since 1999, and particularly well for estimates since 2003. Before 1998, the discard estimates diverge due to low sample size, but generally all estimates show a declining trend from 1996-1999.

These discard estimates did not however reveal the source of the error in the SAW44 discard estimates. Further exploration of the discard rates was conducted to try to understand why skate discards do not appear to be declining despite more restrictive groundfish regulations during the recent period. For vessels using trawls, skate discards per haul, trip, and kept landings increased from 2000 to 2008 (Figure 9). A similar pattern was observed for vessels using sink gillnets (Figure 10). Observed skate discard rates declined for vessels using scallop dredges (Figure 11). In all three cases, the trends could be caused by oversampling trips in special access programs that could have skate discard rates that differ from regular trips.

Skate discards for vessels landing more than 1000 lbs. of skates (live weight) also increased since 2001 (Figure 12), but appear to level off since 2005 and possible decline in 2008 (a partial year). Skate discard rates for vessels fishing in the Gulf of Maine (Figure 14) and the Mid-Atlantic (Figure 16) appeared to vary without trend (Figure 13) at very low levels particularly since 1999, either per trip or per lb. kept. There appears to be a moderate upward trend in discards in Southern New England (Figure 15) since 2000. Skate discard rates on Georges Bank appear to have trended upward since 2001 (Figure 14), mimicking the overall trend.

When broken out by management program, skate discard rates for regular trawl trips in the Georges Bank region varied without trend from 1989 to 2000, then increased in 2001 and varied at a higher level since that time. In the more recent period, discards averaged 0.3 to 0.6 lbs. of skates per pound kept. In contrast, skate discards on oversampled US/CA area trips were much higher, averaging 0.6 to 0.8 lbs. of skate discards per pound kept.

During the comparison of the discard estimates during the DPWS, it was determined that the SAW44 estimates did not include the US/CA area, scallop access area, and groundfish special access program observed trips. It seems plausible that this omission may have contributed to the estimated declining trend in skate discards that was previously estimated. On the other hand, the high skate discard rates in the US/CA trips may also in some cases be inappropriately applied to non-US/CA area trips, but there is no field in the dealer data to determine trip type. Some post-

stratification of DK rates and dealer landings by sub-region and time could reduce this undue influence on the discard estimation.

Also during the DPWS, it was suggested that a General Linear Model (GLM) analysis should be conducted to determine which type of stratification of observed trips would be better a better model to follow. All three stratifications were analyzed via GLM, plus the NEFSC stratification with only regular management program trips (excluding US/CA area, scallop access area, Multispecies Category B DAS, and special access program trips). All models were significant and one stratification wasn't clearly superior to the other, except that simpler models (i.e. less independent variables) explained a significant amount of the DK variance, but all models had relatively low predictive capability (low R).

More detailed information about the GLM analyses are shown in Tables 2-5. For model 1 (Table 2), the MSE for all independent variables except quarter were significant. Holding the effects of the other independent variables constant, the least squares means increased from 2001 to 2007. Trawl DK rates were substantially higher than other gears and higher in the Southern New England region than the others. Similar trends were observed for a GLM applied to only regular management program observed trips (Table 3).

For model 3 (Table 4), which was applied to unmatched trips in this analysis, all independent variables (year, gear, sub-region) were significant and explained a significant fraction of the DK variation. DK trends for year and gear were similar to those for models 1 and 2. DK rates were high for the E. Georges Bank, NY Bight, and Southern New England sub-regions. All independent variables in model 4 (which was used in this analysis to estimate discards on matched trips) were significant (Table 5), except for season which was retained to comport with the survey data to be used to allocate aggregate discards to species. Holding the effects of the other independent variables constant, the least squares means showed a similar trend for year, but the discard rate for trawls was lower than the other model formulations which did not use mesh as an independent variable. Somewhat counter intuitively, the DK rate was highest for large mesh trawls and gillnets, and lowest for small mesh trawls and gillnets. This may be related to the lower amount of kept for other species compared to the discard of skates for vessels using large mesh. It also suggests that vessels using mesh larger than 8 inches may have a lower skate discard rate – or simply catch more of the target species relative to the amount of skates discarded.

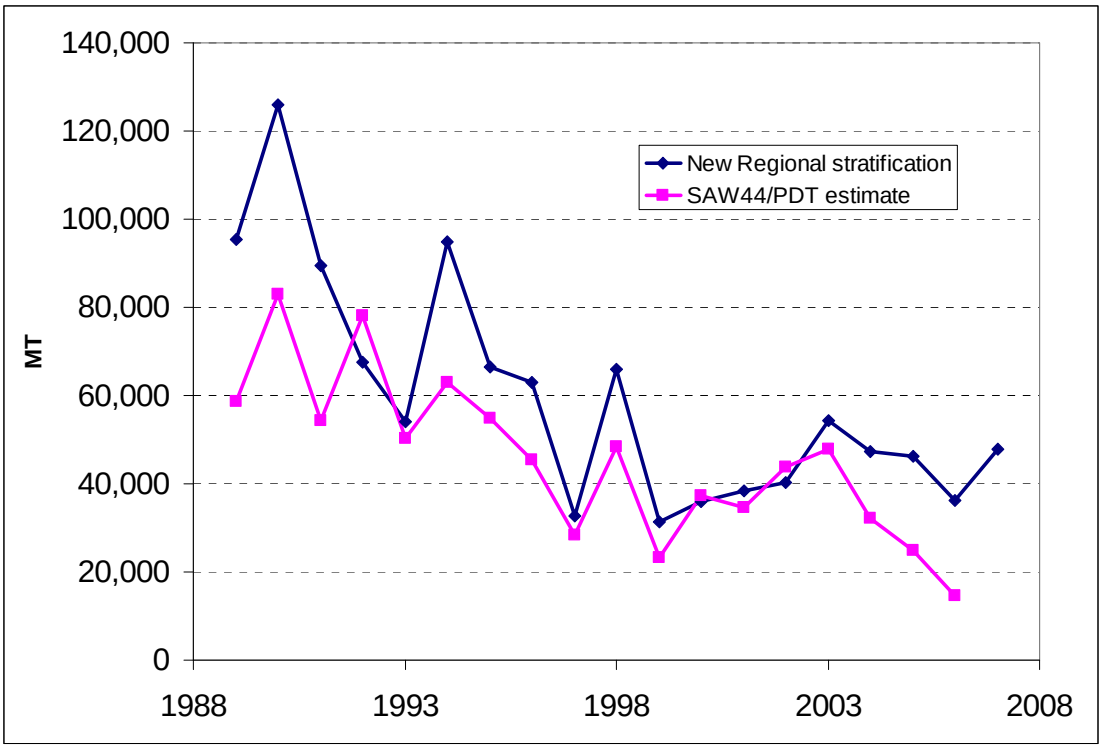


Figure 1. Comparison of new NEFSC discard estimates with SAW44/PDT discard estimates.

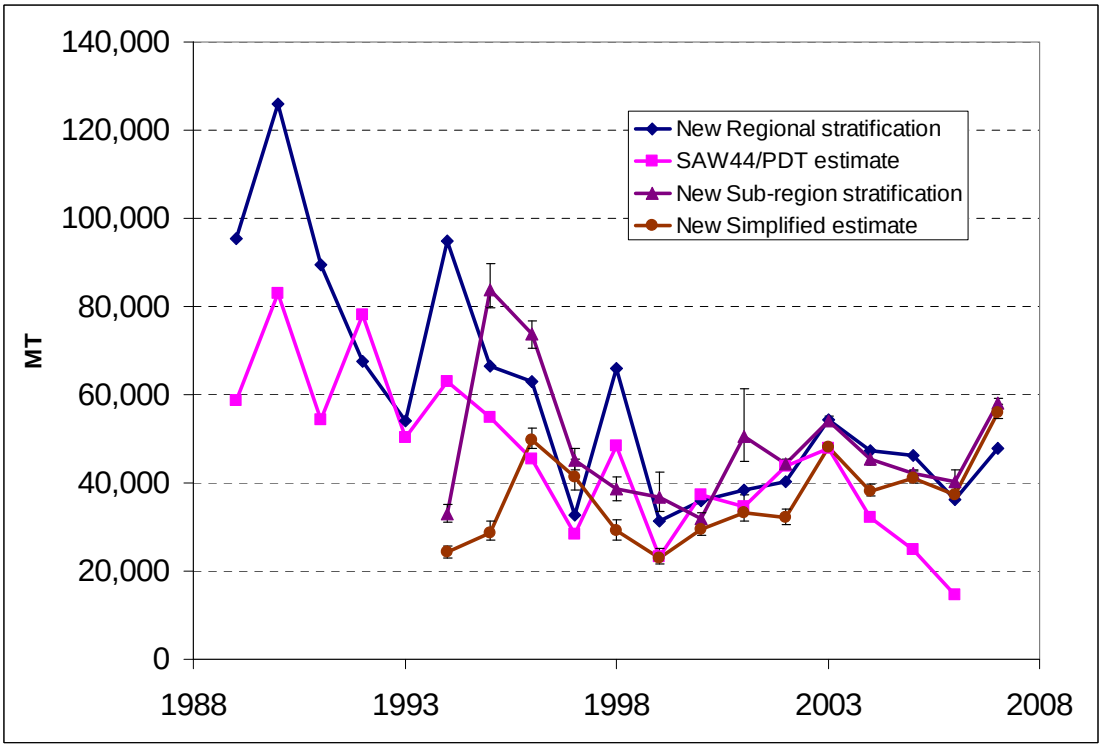


Figure 2. Comparison of discard estimates, including one using a simplified method and a re-stratification at the subregion level (gear, sub-region, season, mesh)

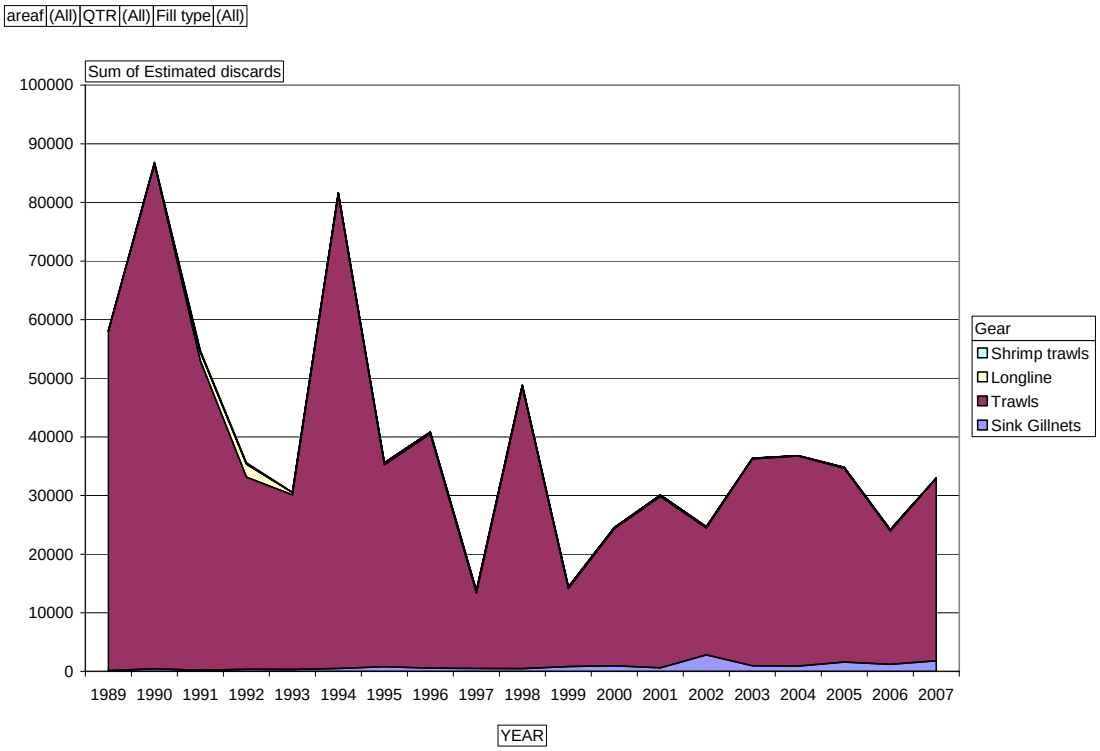


Figure 3. Match trips and all fill types: Estimated discards by gear type via the new NEFSC skate discard estimation.

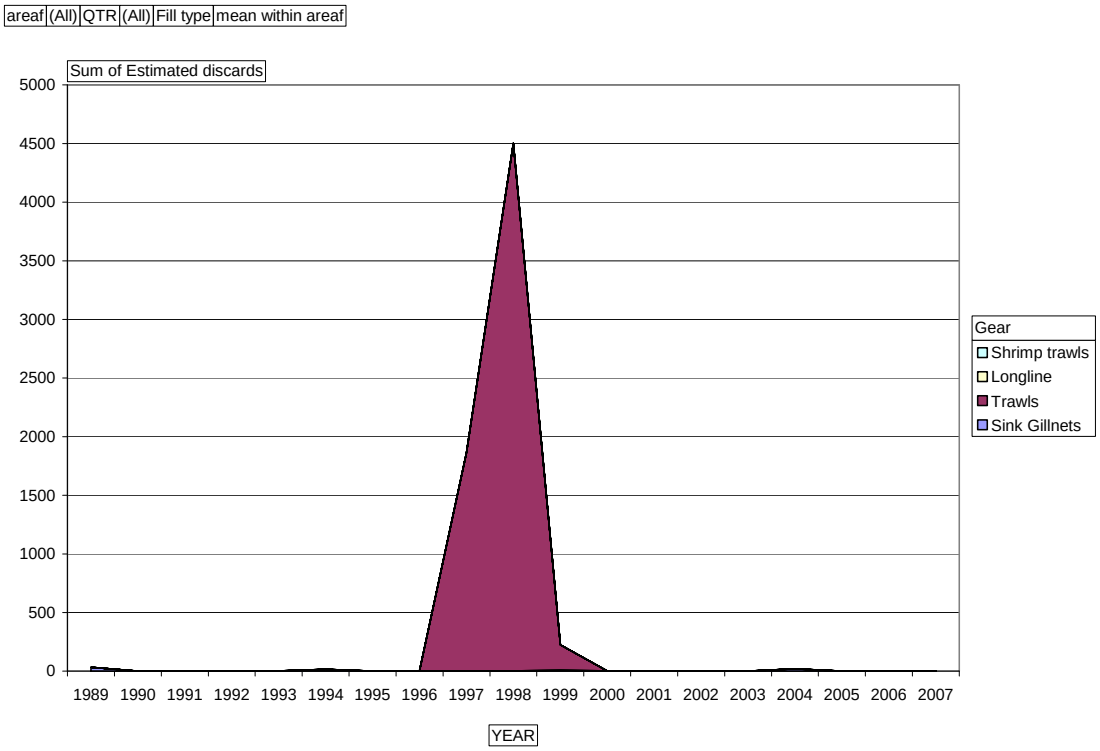


Figure 4. Mean within area fill: Estimated discards by gear type via the new NEFSC skate discard estimation.

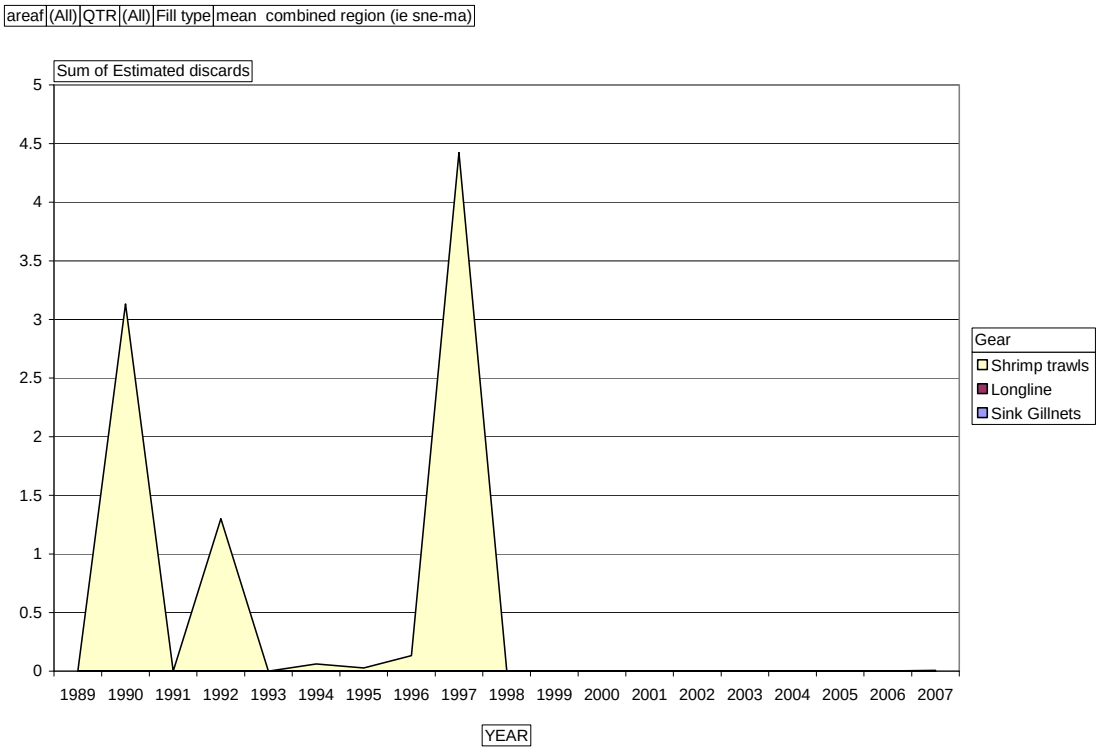


Figure 5. Mean within region fill: Estimated discards by gear type via the new NEFSC skate discard estimation.

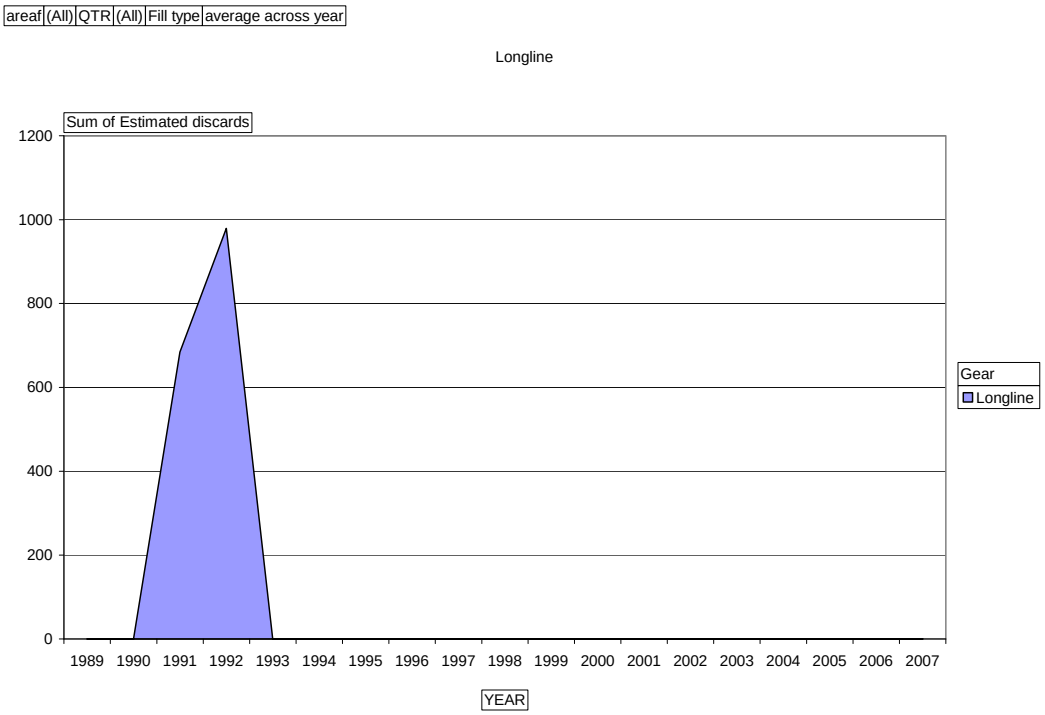


Figure 6. Mean within year fill: Estimated discards by gear type via the new NEFSC skate discard estimation.

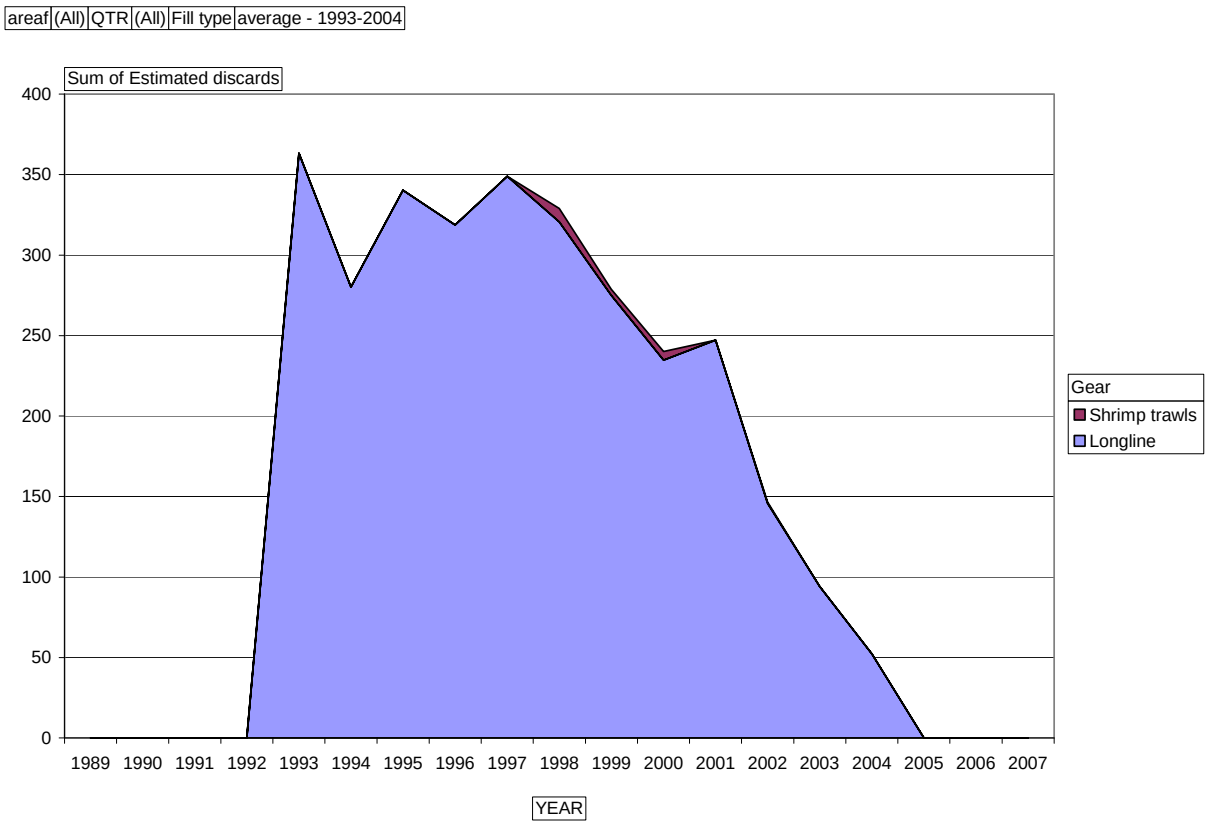


Figure 7. Mean for gear fill: Estimated discards by gear type via the new NEFSC skate discard estimation.

Fill type	None

Average of dkratio		Gear areaf																				
		Longline				Scallop dredges				Shrimp trawls		Sink Gillnets				Trawls				Grand Total
YEAR	QTR	GBK	GOM	MA	SNE	GBK	GOM	MA	SNE	GBK	GOM	GBK	GOM	MA	SNE	GBK	GOM	MA	SNE	
1989	1									0.000	0.020				0.000	0.802	0.346	0.213	1.688	0.438
	2										0.042	0.003			0.000	0.272	0.166	0.024	0.297	0.115
	3											0.005	0.003		0.000	0.286	0.128	0.510	1.136	0.295
	4										0.018	0.018	0.008		0.000	0.386	0.194	0.145	0.569	0.167
1990	1										0.050	0.014	0.107			1.037	0.246	0.144	2.583	0.597
	2										0.011	0.013	0.047	0.000		0.335	0.130	0.103	0.081	0.090
	3											0.000	0.003			0.125	0.028	0.384	0.131	0.112
	4										0.114	0.002	0.009	0.000	0.000	0.281	0.280	0.426	1.825	0.326
1991	1	0.774								0.289	0.069	0.005	0.041	0.000		0.345	0.123	0.009	0.706	0.236
	2										0.038	0.007	0.014	0.000		0.399	0.042	0.444	0.451	0.174
	3											0.019	0.008		0.000	0.075	0.083	1.595	0.363	0.306
	4	0.174	0.041								0.129	0.045	0.007		0.000	0.516	0.086	0.209	0.257	0.147
1992	1	0.906	0.110								0.078	0.053	0.104	0.000	0.016	0.474	0.102	0.109	0.027	0.180
	2	0.222		0.000							0.000	0.013	0.017		0.053	0.100	0.014	0.020	0.395	0.083
	3											0.002	0.003		0.067	0.029	0.024	0.212	0.231	0.081
	4										0.001	0.039	0.005		0.018	0.170	0.048	0.609	0.591	0.185
1993	1		0.088	0.000						0.000	0.018	0.017	0.050	0.000	0.044	0.116	0.146	0.024	0.060	0.047
	2			0.068								0.005	0.017		0.041	0.257	0.053	0.045	0.645	0.141
	3			0.000								0.002	0.002	0.000	0.170	0.020	0.025	0.047	0.866	0.126
	4										0.003	0.020	0.004	0.002	0.011	0.748	0.079	0.444	0.258	0.174
1994	1	0.000		0.000							0.005	0.007	0.103	0.007	0.014	0.204	0.030	0.099	0.004	0.043
	2											0.000	0.003	0.003	0.069	0.466	0.070	5.436	2.257	1.038
	3											0.000	0.001	0.001		0.239	0.071	0.048	0.071	0.061
	4										0.001	0.016	0.013	0.013	0.084	0.892	0.026	0.134	0.321	0.166
1995	1										0.002	0.031	0.097	0.014	0.077	0.415	0.048	0.632	0.101	0.157
	2											0.003	0.018	0.010	0.063	0.758	0.035	0.302	0.489	0.210
	3											0.003	0.003	0.004	0.114	0.120	0.011	0.106	0.107	0.058
	4										0.000	0.013	0.050	0.013	0.014	0.235	0.031	0.553	0.137	0.116
1996	1										0.004	0.035	0.216	0.016	0.004	0.615	0.033	0.225	0.132	0.142
	2										0.000	0.002	0.017	0.010	0.013	0.322	0.048	0.036	0.303	0.083
	3											0.008	0.004	0.007	0.000		0.000	0.004	2.012	0.291
	4										0.005	0.011	0.001	0.008	0.014	0.081	0.035	0.074	1.442	0.186
1997	1									0.001	0.006	0.005	0.048	0.019	0.002	0.241	0.128	0.079	0.125	0.065
	2											0.008	0.012	0.046	0.000		0.011		0.058	0.023
	3											0.001	0.000	0.000	0.030	0.145	0.004	0.003	0.531	0.089
	4											0.008	0.002	0.009	0.021	0.270		0.016	0.041	0.052
1998	1											0.022	0.021	0.008	0.002	0.169	0.092	0.051	0.072	0.055
	2											0.002	0.003	0.025	0.006		0.023	1.984	0.183	0.318
	3			0.087								0.022	0.001	0.028		0.148	0.579	0.113	0.064	0.130
	4											0.004	0.007	0.017	0.016	1.149		0.116	0.185	0.213
1999	1											0.090	0.008	0.021	0.014	0.004		0.010	0.006	0.022
	2											0.003	0.015	0.079	0.013	0.370	0.020	0.139	0.008	0.081
	3											0.003	0.003	0.000		0.405	0.042	0.009		0.077
	4											0.004	0.037	0.015	0.058	0.421	0.007	0.112	0.101	0.094
2000	1											0.016	0.015	0.000	0.023	0.123	0.151	0.039	0.094	0.057
	2											0.038	0.032	0.005	0.032	0.294	0.108	0.123	0.153	0.098
	3											0.486	0.007	0.000		0.197	0.016	0.011	0.186	0.129
	4											0.096	0.012	0.009	0.012	0.543	0.053	0.446	0.466	0.204
2001	1										0.000	0.058	0.020	0.004	0.000	1.129	0.062	0.004	0.041	0.146
	2											0.018	0.056	0.006	0.183	0.144	0.056	0.071	0.323	0.107
	3											0.009	0.011	0.000	0.000	0.164	0.064	0.014	0.114	0.047
	4											0.078	0.010	0.005	0.016	0.308	0.037	0.062	0.217	0.092
2002	1											0.033	0.002	0.029	0.035	0.459	0.031	0.065	0.000	0.082
	2											0.119	0.016	0.015	0.045	0.422	0.092	0.080	0.045	0.104
	3	0.212										0.022	0.052	0.000	0.021	0.309	0.072	0.058	0.081	0.092
	4	0.033	0.000		0.456							0.030	0.013	0.003	1.702	0.289	0.095	0.216	0.333	0.288
2003	1	0.155	0.057			0.018	0.042	0.073	0.008		0.009	0.286	0.029	0.025	0.069	0.576	0.077	0.186	0.716	0.150
	2					0.156		0.114				0.019	0.018	0.004	0.046	0.315	0.080	0.160	0.035	0.096
	3					0.099		0.217				0.036	0.011	0.000	0.055	0.472	0.085	0.005	2.266	0.315
	4	0.000				0.108		0.043	0.396			0.021	0.008	0.024	0.103	0.451	0.057	0.105	0.348	0.130
2004	1	0.013	0.011			0.045	0.003	0.062			0.004	0.064	0.026	0.000	0.036	0.446	0.049	0.064	0.111	0.067
	2							0.067				0.022	0.018	0.000	0.044	0.568	0.119	0.079	0.173	0.116
	3	0.035						0.083				0.046	0.009		0.025	0.620	0.042	0.023	0.729	0.169
	4	0.008		0.000	0.000	0.056	0.139	0.074	0.383			0.069	0.021	0.049	0.053	0.562	0.119	0.044	0.865	0.164
2005	1	0.093	0.052		0.000	0.025	0.051	0.147	0.263		0.003	0.767	0.051	0.025	0.059	0.538	0.059	0.045	0.168	0.140
	2	0.289	0.024			0.035		0.065				0.007	0.034	0.104	0.089	0.571	0.060	0.327	0.951	0.190
	3	0.105	0.012			0.039		0.082	0.397			0.045	0.009	0.038	0.106	0.718	0.067	0.155	0.627	0.168
	4	0.034	0.001	0.000	0.000	0.032		0.110	0.334			0.117	0.007	0.052	0.061	0.682	0.174	0.110	0.649	0.147
2006	1	0.498	0.040		0.008	0.041		0.076			0.000	0.023	0.050	0.035	0.067	0.717	0.106	0.034	0.174	0.130
	2	0.234		0.000		0.013						0.229	0.030	0.086	0.330	0.451	0.178	0.036	0.071	0.139
	3	0.000	0.000		0.000	0.048		0.140	0.152			0.058	0.008	0.003	0.126	0.730	0.079	0.021	0.274	0.114
	4	0.054	0.039	0.000	0.001	0.069		0.251	0.339		0.001	0.100	0.006	0.022	0.002	0.715	0.077	0.079	0.231	0.128
2007	1	0.376	0.093			0.036		0.106	0.794		0.000	0.622	0.018	0.025	0.119	0.680	0.153	0.109	0.178	0.216
	2	0.046	0.034			0.015	0.047	0.052	0.125			0.033	0.019	0.117	0.075	0.556	0.062	0.547	0.415	0.138
	3	0.081	0.091	0.000		0.031		0.068				0.069	0.013	0.013	0.040	1.062	0.031	0.050	0.479	0.142
	4	0.051	0.005	0.000	0.000	0.228	0.106	0.086	1.178			0.083	0.011	0.019	0.419	0.645	0.081	0.213	0.382	0.263
Grand Total		0.183	0.041	0.013	0.058	0.059	0.065	0.102	0.456	0.073	0.022	0.057	0.024	0.017	0.075	0.423	0.086	0.261	0.451	0.160

Figure 8. Observed D/K ratios by stratum, NEFSC estimation.

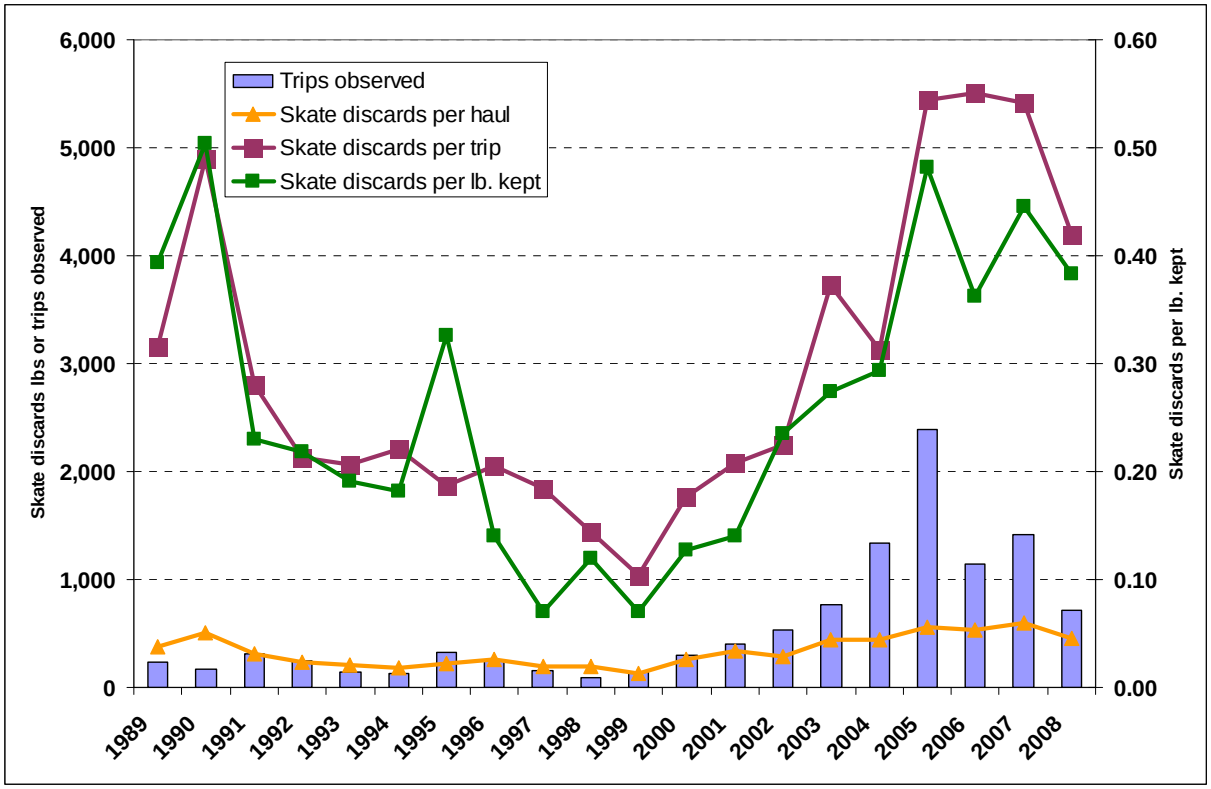


Figure 9. Observed skate discard rate for vessels using trawls.

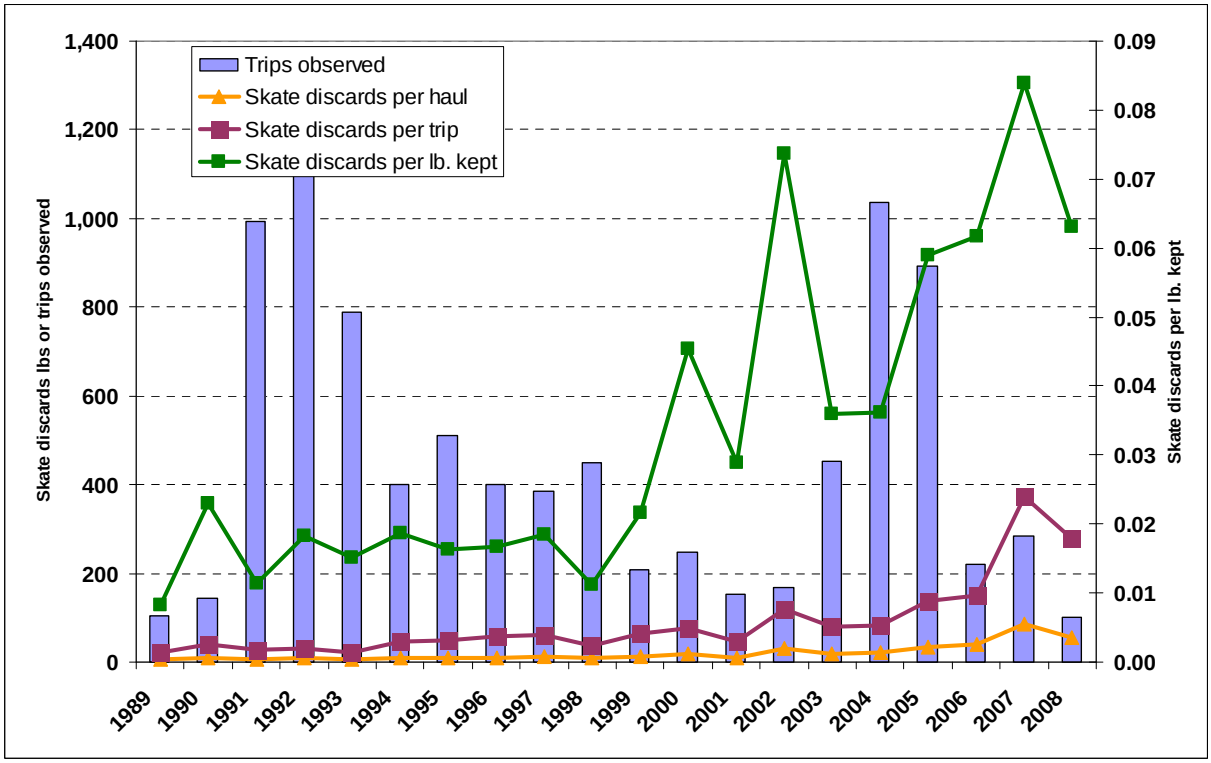


Figure 10. Observed skate discard rate for vessels using sink gillnets.

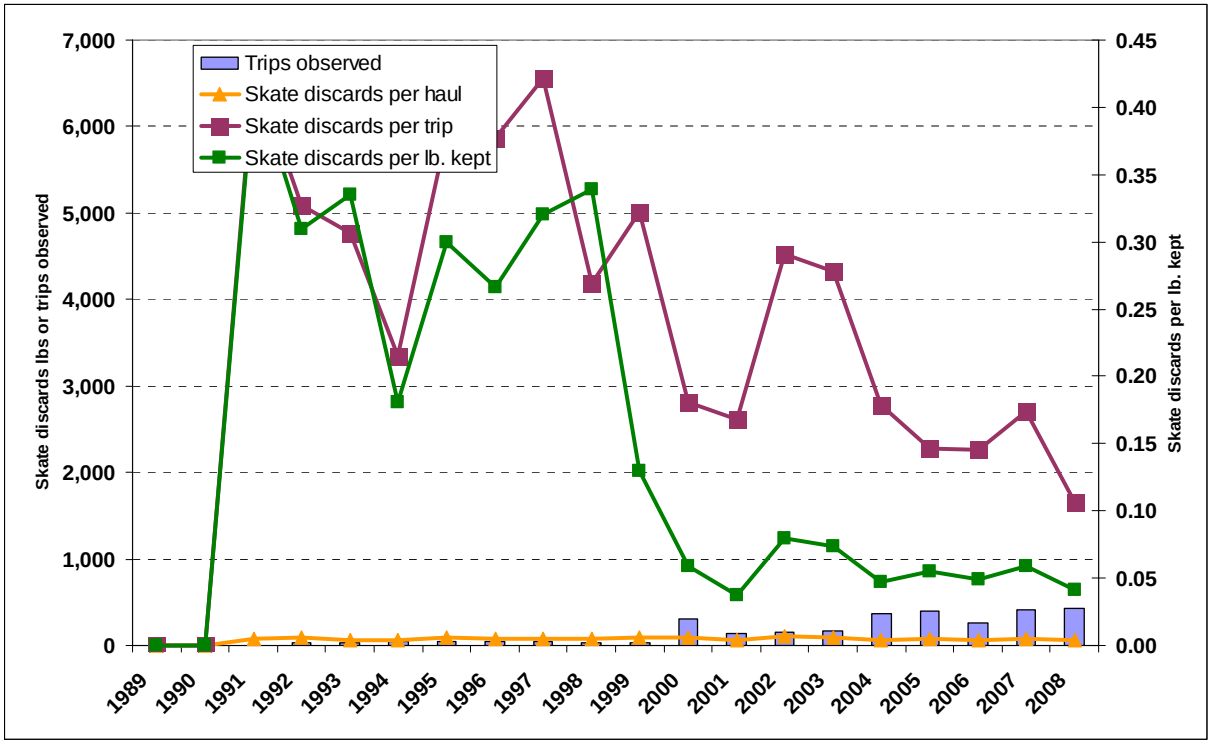


Figure 11. Observed skate discard rate for vessels using scallop dredges.

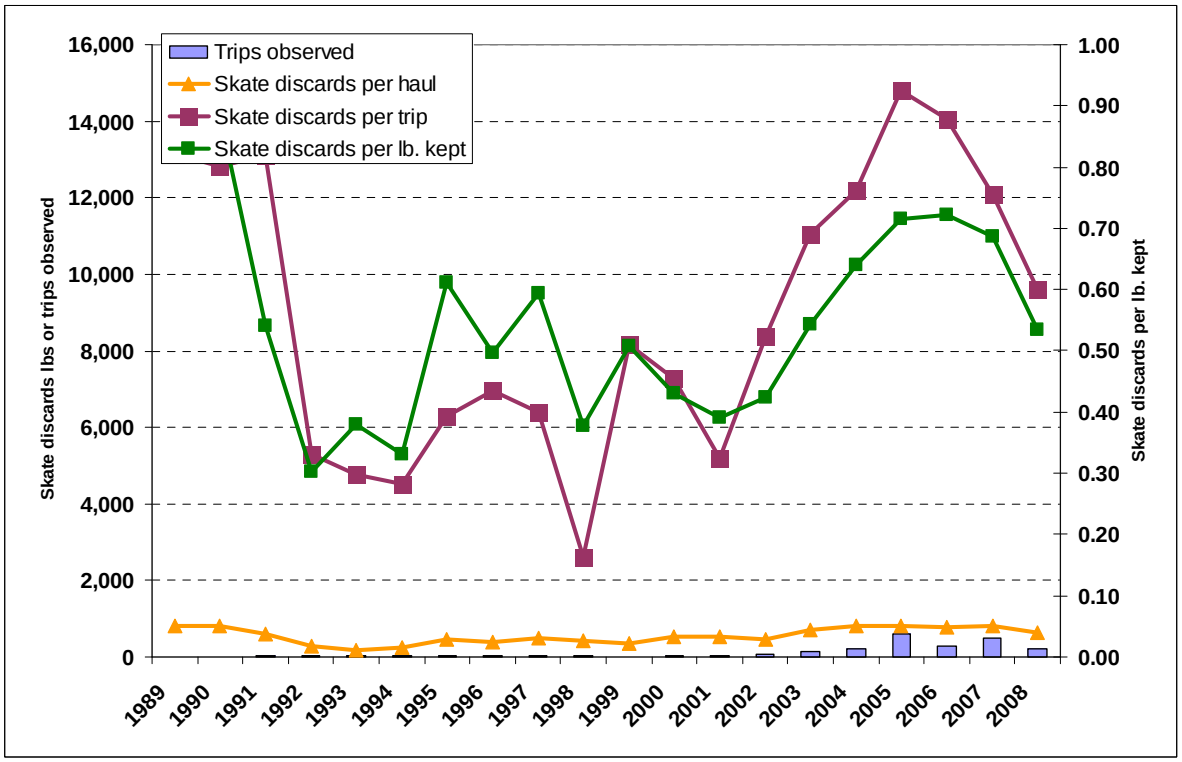


Figure 12. Observed skate discard rate for vessels landing > 1000 lbs. of skate, live weight.

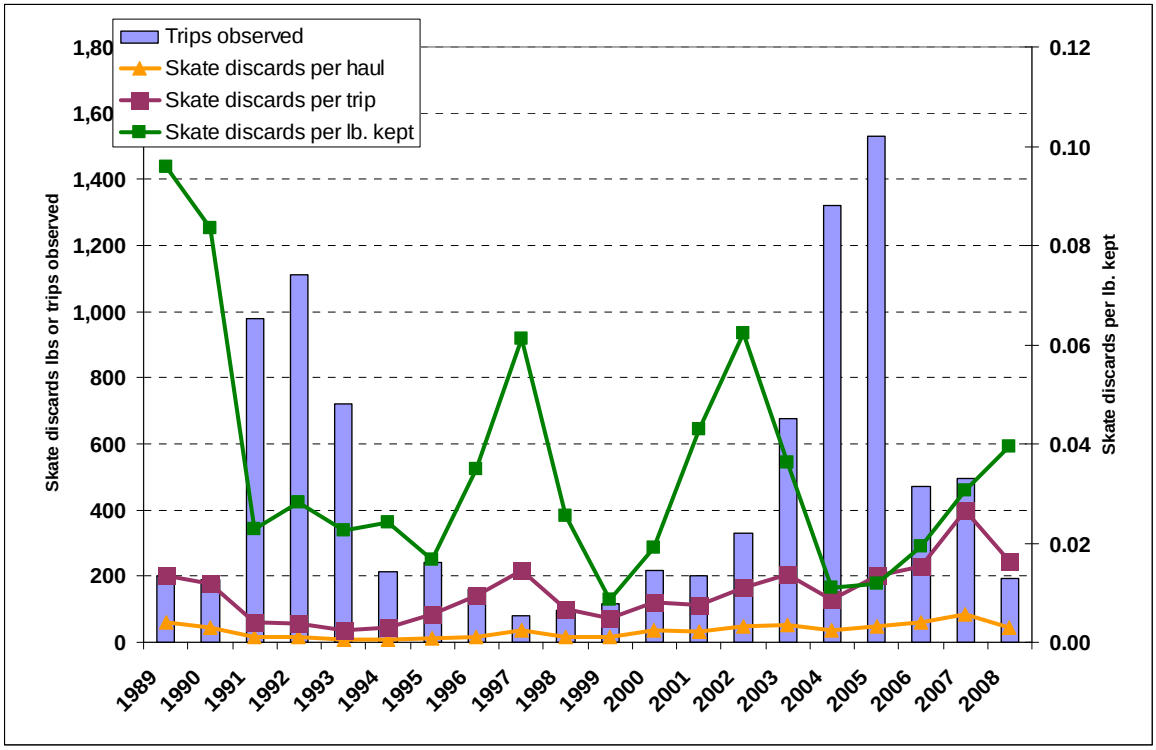


Figure 13. Observed skate discard rate for vessels fishing in the Gulf of Maine.

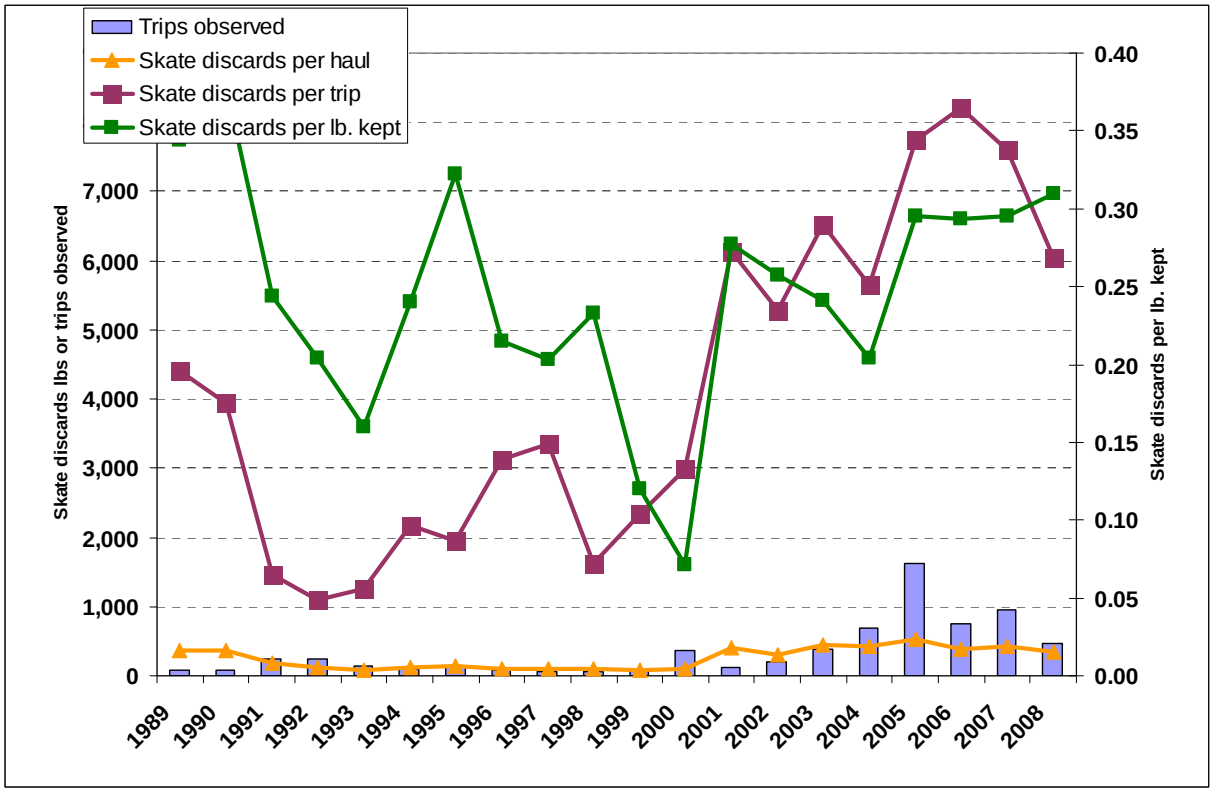


Figure 14. Observed skate discard rate for vessels fishing on Georges Bank.

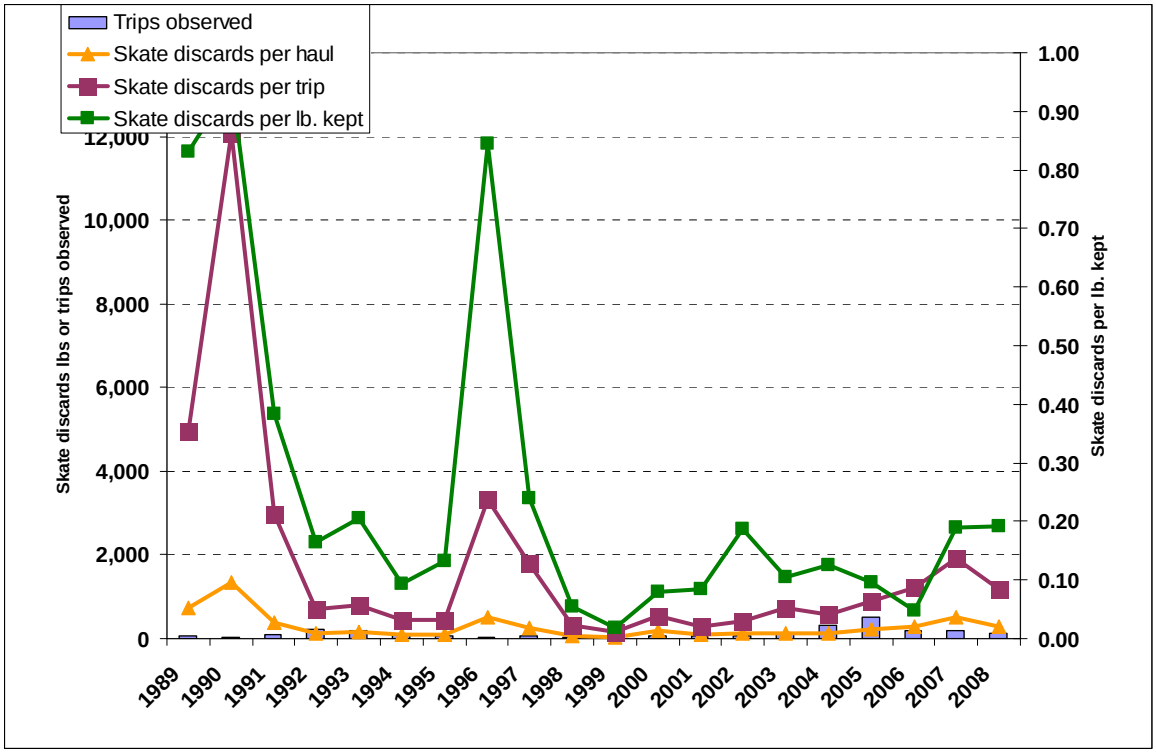


Figure 15. Observed skate discard rate for vessels fishing in Southern New England.

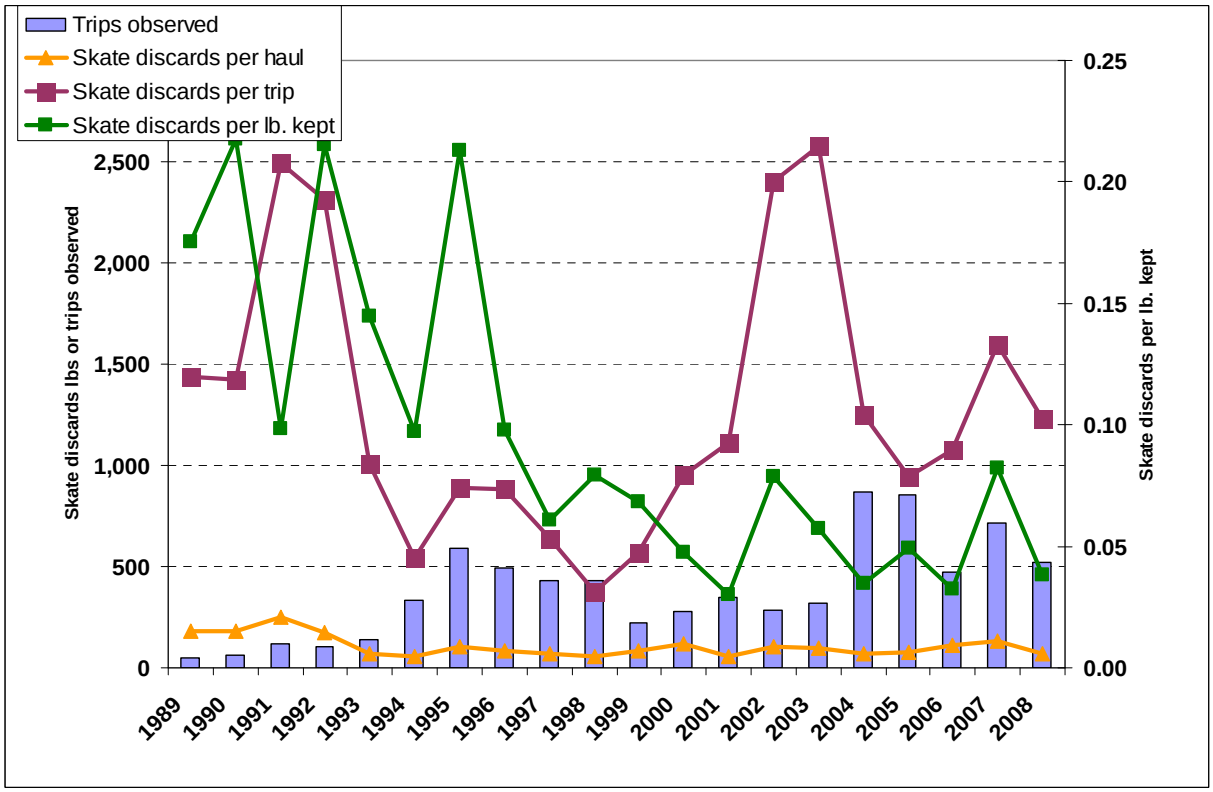


Figure 16. Observed skate discard rate for vessels fishing in the Mid-Atlantic.

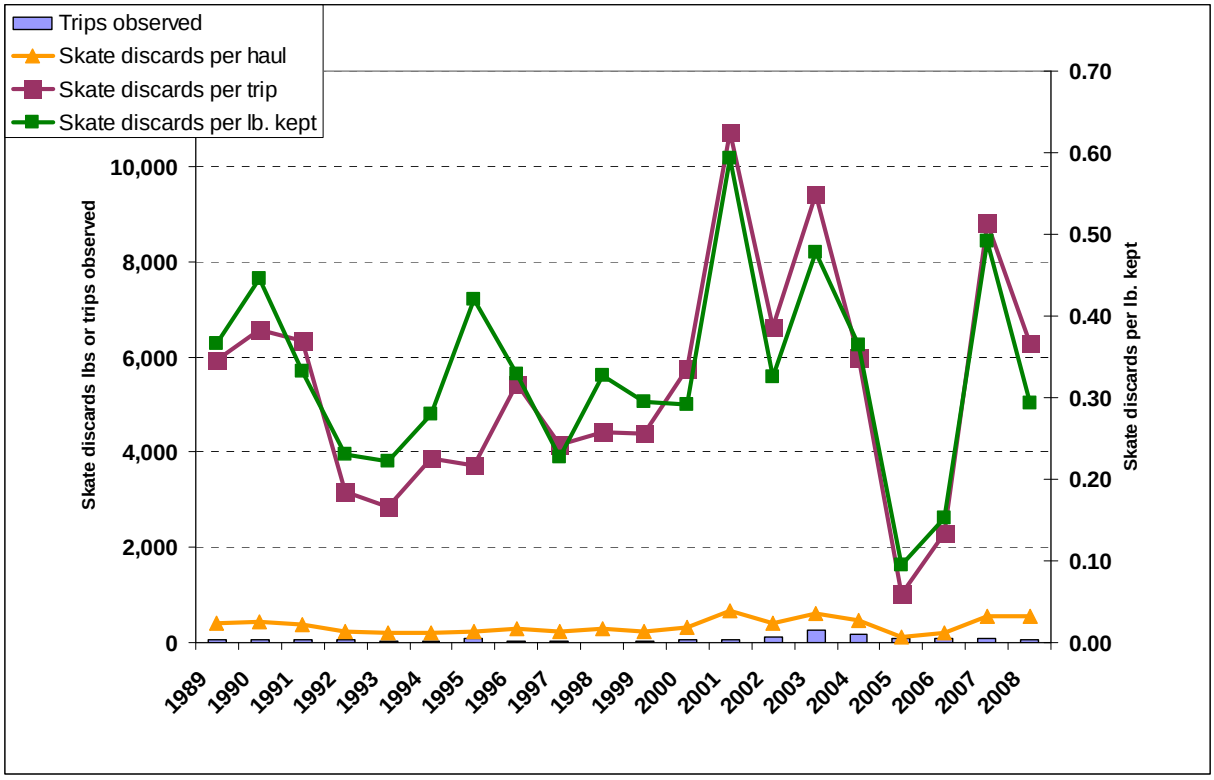


Figure 17. Observed skate discards for vessels using trawls on regular Georges Bank region trips.

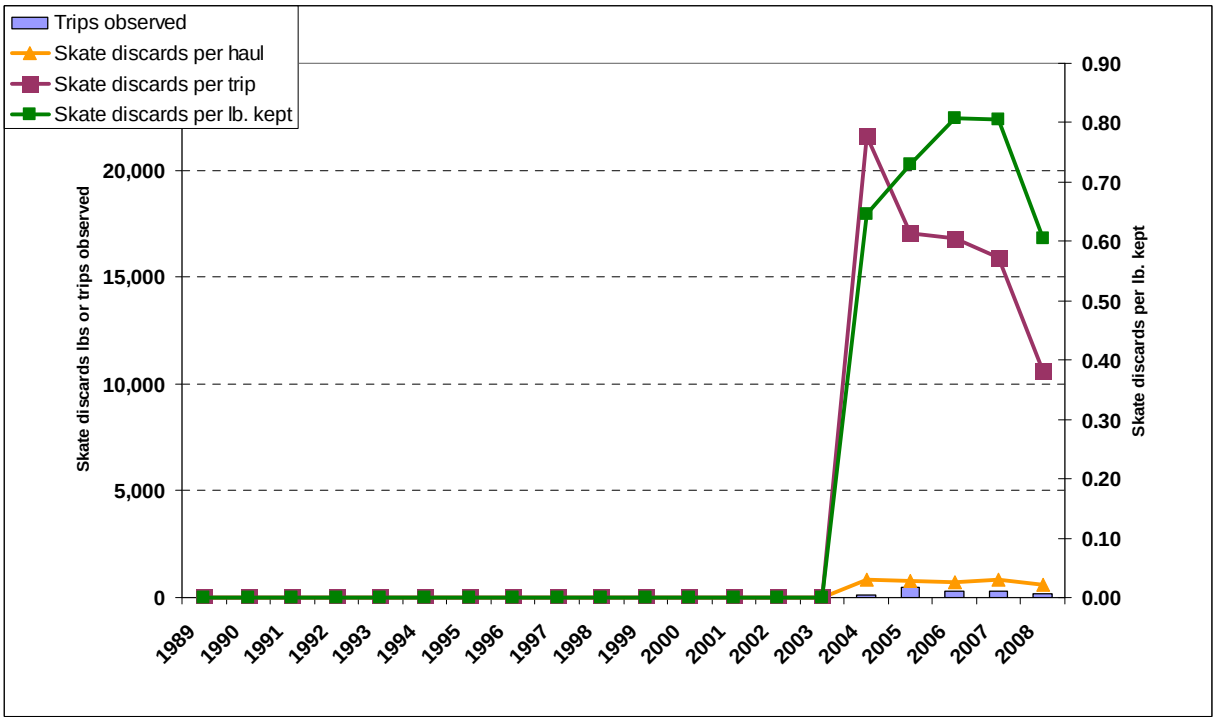


Figure 18. Observed skate discards for vessels using trawls on US/CA trips in the E. Georges Bank sub-region.

Table 1. GLM statistics for various independent variables predictors of average observed DK ratios.

Stratification model	Statistic					
	Multiple R	F-ratio (df)	p-value	Kolmogorov -Smirnov	Durbin-Watson D	AIC
1. NEFSC	0.127	13.45 (24)	0	0.361	1.927	90,347
2. NEFSC regular trips	0.112	7.573 (24)	0	0.378	1.945	69,420
3. Gear/ Sub-region	0.136	14.012 (27)	0	0.358	1.930	92,665
4. Gear/ sub-region/ season/mesh	0.136	9.902 (28)	0	0.368	1.941	71,517

Table 2. GLM statistics and results for Model 1, gear/region/quarter.

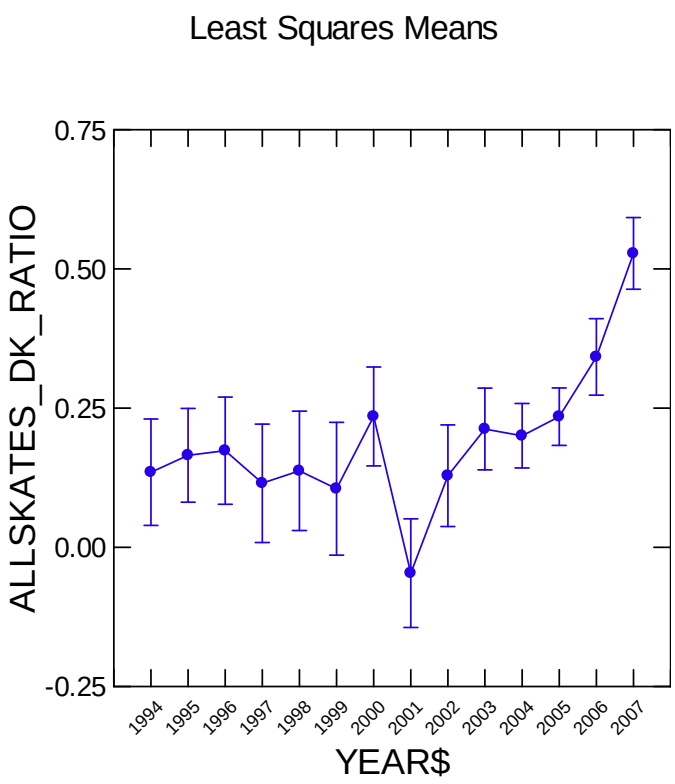
Analysis of Variance

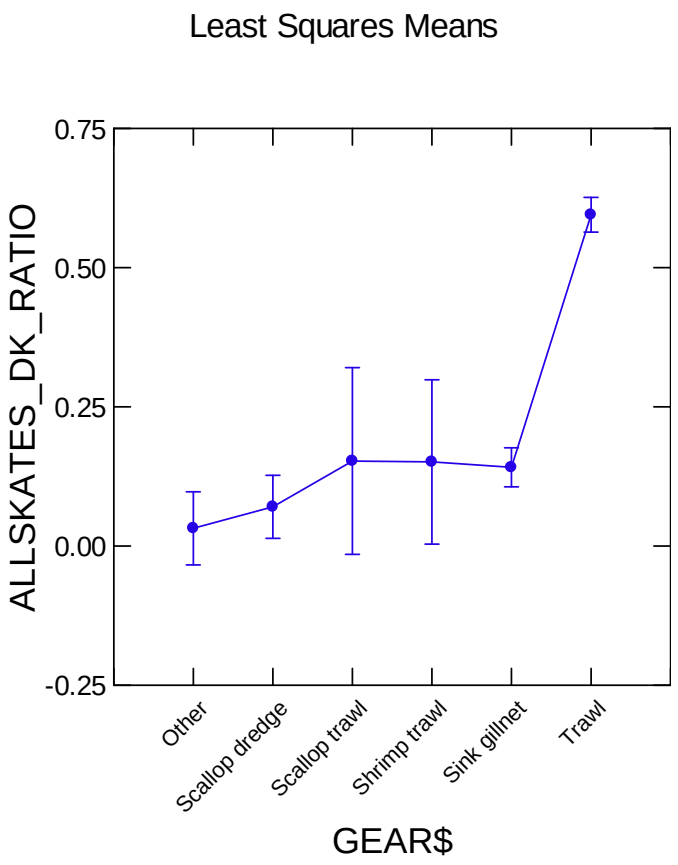
Source	Type III SS	df	Mean Squares	F-ratio	p-value
YEAR$	307.2600	13	23.6354	4.0798	0.0000
GEAR$	1035.3742	5	207.0748	35.7442	0.0000
REGION$	140.1059	3	46.7020	8.0615	0.0000
QTR$	23.3255	3	7.7752	1.3421	0.2587
Error	113738.7331	19633	5.7932		

Estimates of Effects B = $(X'X)^{-1}X'Y$

Factor	Level	ALLSKATES_DK_RA-TIO
CONSTANT		0.1932
YEAR$	1994	-0.0532
YEAR$	1995	-0.0242
YEAR$	1996	-0.0193
YEAR$	1997	-0.0731
YEAR$	1998	-0.0556
YEAR$	1999	-0.0910
YEAR$	2000	0.0417
YEAR$	2001	-0.2394
YEAR$	2002	-0.0589
YEAR$	2003	0.0209
YEAR$	2004	0.0098
YEAR$	2005	0.0469
YEAR$	2006	0.1568
GEAR$	Other	-0.1614
GEAR$	Scallop dredge	-0.1201
GEAR$	Scallop trawl	-0.0262
GEAR$	Shrimp trawl	-0.0413
GEAR$	Sink gillnet	-0.0526

Estimates of Effects B = $(X'X)^{-1}X'Y$		
Factor	**Level**	**ALLSKATES_DK_RATIO**
REGION$	GB	-0.0575
REGION$	GOM	-0.1278
REGION$	MA	0.0080
QTR$	1.000000	-0.0405
QTR$	2.000000	0.0334
QTR$	3.000000	-0.0295




Least Squares Means
ALLSKATES_DK_RATIO
0.75
0.50
0.25
0.00
-0.25
Other
Scallop dredge
Scallop trawl
Shrimp trawl
Sink gillnet
Trawl
GEAR$

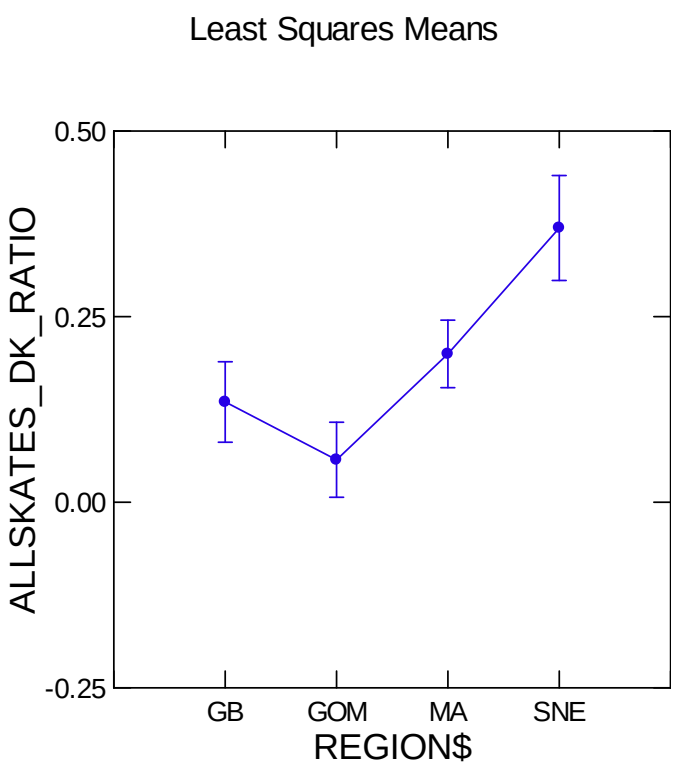

Least Squares Means
ALLSKATES_DK_RATIO
0.50
0.25
0.00
-0.25
GB
GOM
MA
SNE
REGION$

Table 3. GLM statistics and results for Model 2, gear/region/quarter, using only regular management program observed trips.

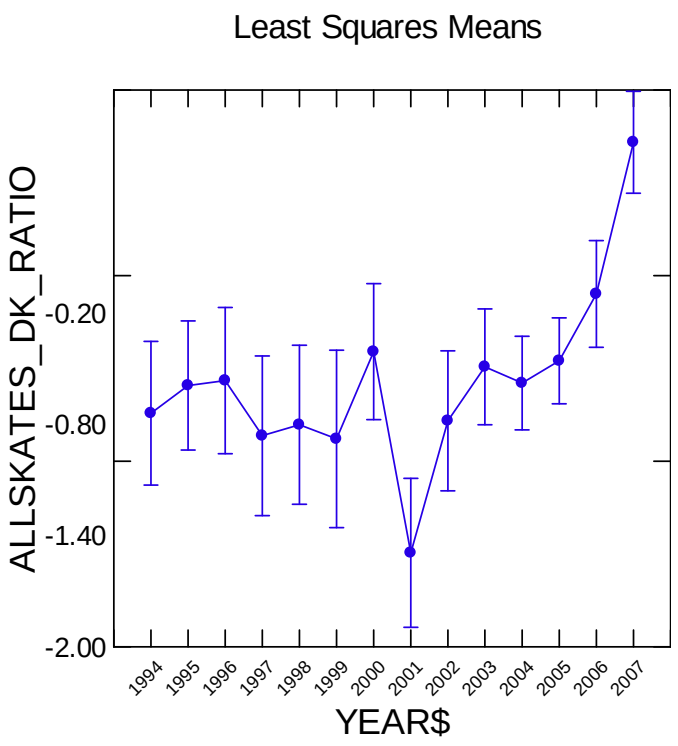
Analysis of Variance					
Source	**Type III SS**	**df**	**Mean Squares**	**F-ratio**	**p-value**
YEAR$	371.1617	13	28.5509	3.8103	0.0000
GEAR$	601.7510	5	120.3502	16.0615	0.0000
REGION$	67.3027	3	22.4342	2.9940	0.0296
QTR$	33.3625	3	11.1208	1.4841	0.2166
Error	106679.1384	14237	7.4931		

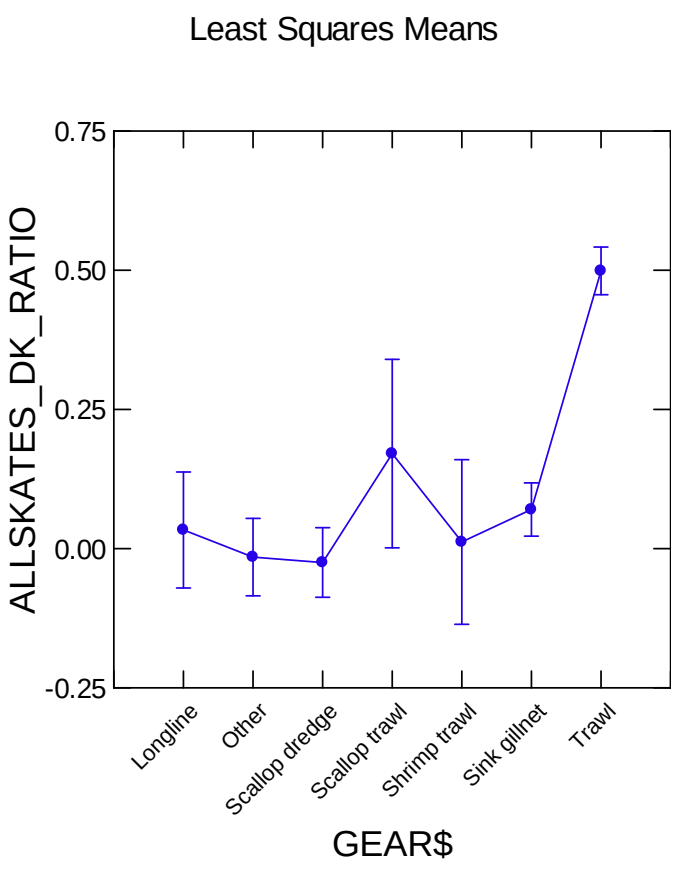
Estimates of Effects $B = (X'X)^{-1}X'Y$		
Factor	**Level**	**ALLSKATES_DK_RATIO**
CONSTANT		0.2075
YEAR$	1994	-0.0629
YEAR$	1995	-0.0254
YEAR$	1996	0.0037
YEAR$	1997	-0.0752
YEAR$	1998	-0.0660
YEAR$	1999	-0.1071
YEAR$	2000	0.0294
YEAR$	2001	-0.2749
YEAR$	2002	-0.0525
YEAR$	2003	0.0028
YEAR$	2004	-0.0375
YEAR$	2005	0.0097
YEAR$	2006	0.1379
GEAR$	Other	-0.1651
GEAR$	Scallop dredge	-0.0354
GEAR$	Scallop trawl	0.0017
GEAR$	Shrimp trawl	-0.1078
GEAR$	Sink gillnet	-0.0570
REGION$	GB	-0.0754
REGION$	GOM	-0.0773
REGION$	MA	-0.0015
QTR$	1.000000	-0.0389
QTR$	2.000000	0.0372
QTR$	3.000000	-0.0556

Table 4. GLM statistics and results for Model 3, DK rates post stratified by gear and sub-region.

Analysis of Variance					
Source	**Type III SS**	**df**	**Mean Squares**	**F-ratio**	**p-value**
YEAR$	277.7085	13	21.3622	3.8130	0.0000
GEAR$	966.1356	6	161.0226	28.7414	0.0000
SUB_REGION$	378.6510	8	47.3314	8.4483	0.0000
Error	113629.0190	20282	5.6025		

Factor	**Level**	**ALLSKATES_DK_RATIO**
CONSTANT		0.1064
YEAR$	1994	-0.0418
YEAR$	1995	-0.0045
YEAR$	1996	0.0022
YEAR$	1997	-0.0721
YEAR$	1998	-0.0573
YEAR$	1999	-0.0764
YEAR$	2000	0.0412
YEAR$	2001	-0.2299
YEAR$	2002	-0.0521
YEAR$	2003	0.0208
YEAR$	2004	-0.0011
YEAR$	2005	0.0288
YEAR$	2006	0.1189
GEAR$	Longline	-0.0729
GEAR$	Other	-0.1217
GEAR$	Scallop dredge	-0.1314
GEAR$	Scallop trawl	0.0643
GEAR$	Shrimp trawl	-0.0946
GEAR$	Sink gillnet	-0.0362
SUB_REGION$	Delmarva	-0.0171
SUB_REGION$	E. GB	0.1545
SUB_REGION$	E. GM	-0.3530
SUB_REGION$	NY Bight	0.2262
SUB_REGION$	Offshore	-0.2487
SUB_REGION$	Other	0.0182
SUB_REGION$	S. Channel	-0.0531
SUB_REGION$	SNE	0.2751


Least Squares Means
ALLSKATES_DK_RATIO
-0.20
-0.80
-1.40
-2.00
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR$


Least Squares Means
ALLSKATES_DK_RATIO
0.75
0.50
0.25
0.00
-0.25
Longline
Other
Scallop dredge
Scallop trawl
Shrimp trawl
Sink gillnet
Trawl
GEAR$

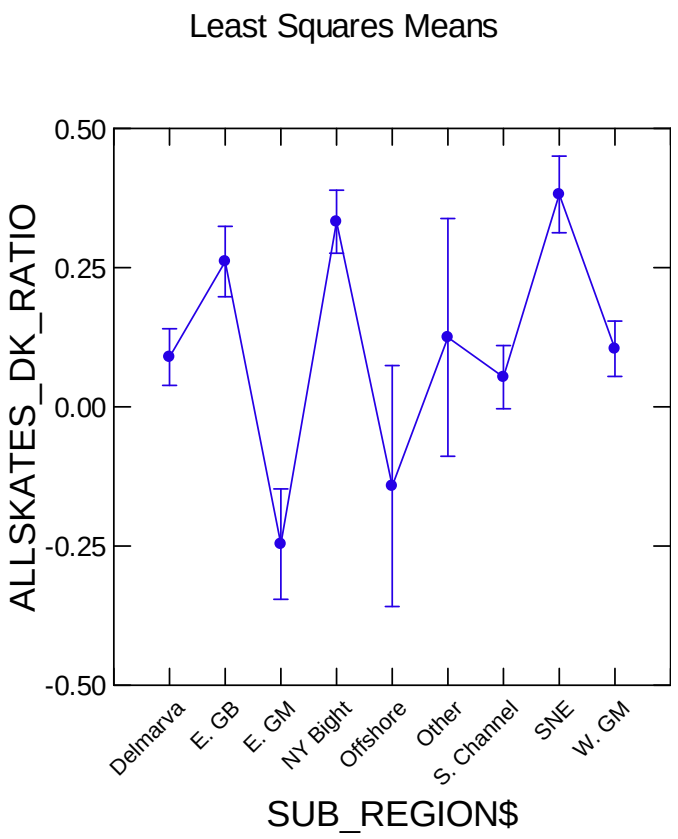
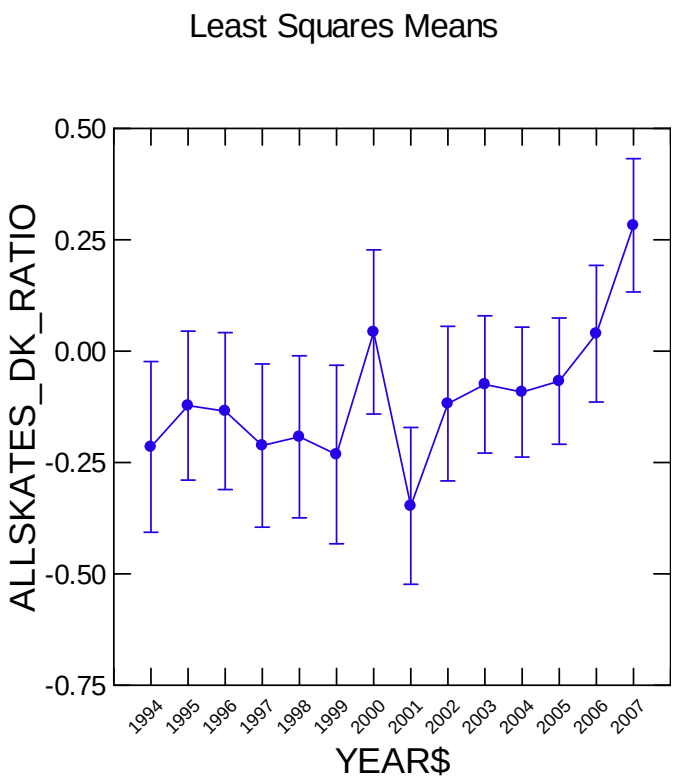
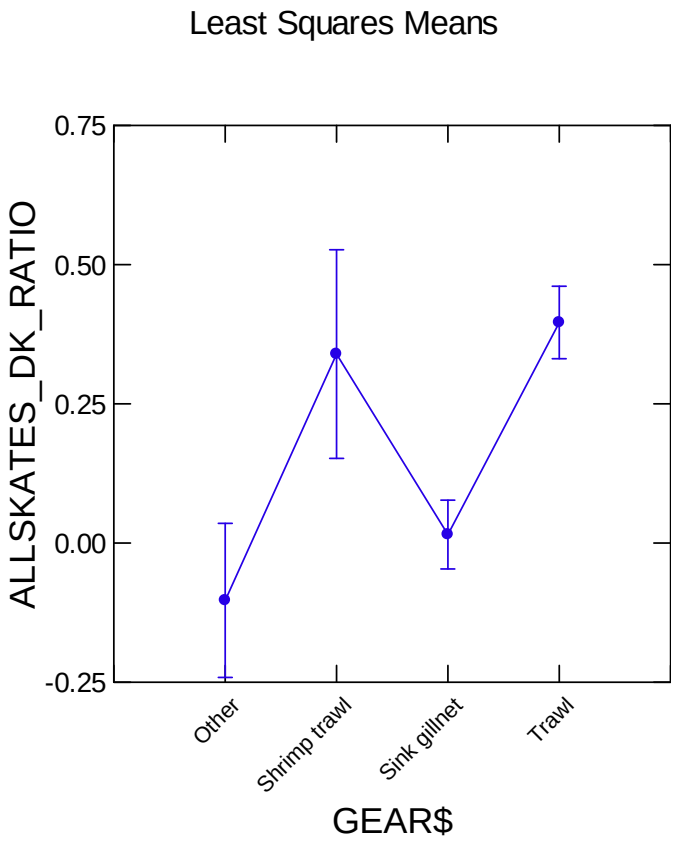

Least Squares Means
0.50
0.25
0.00
-0.25
-0.50
ALLSKATES_DK_RATIO
Delmarva
E. GB
E. GM
NY Bight
Offshore
Other
S. Channel
SNE
W. GM
SUB_REGION$

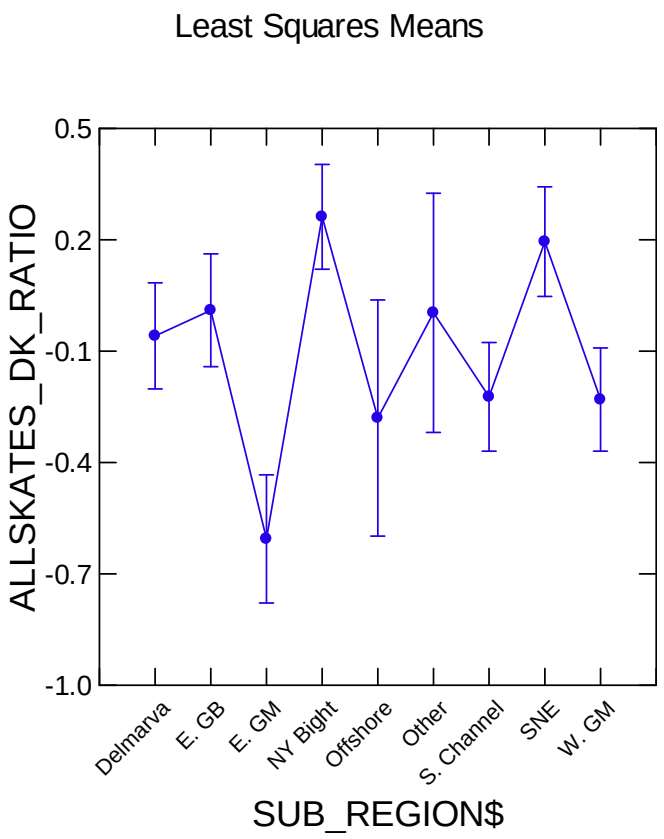
Table 5. GLM statistics and results for Model 4, DK rates post stratified by gear, sub-region, season, and mesh.

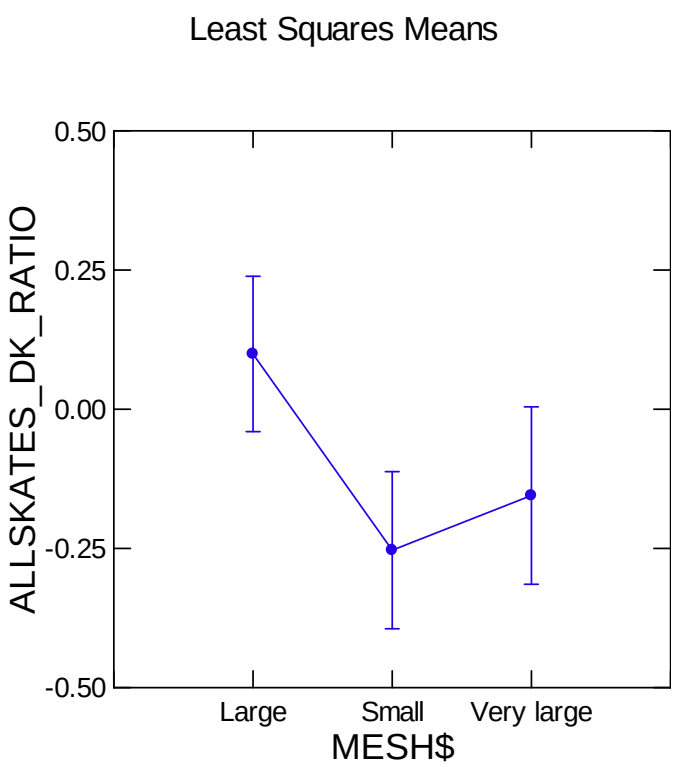
Analysis of Variance					
Source	**Type III SS**	**df**	**Mean Squares**	**F-ratio**	**p-value**
YEAR$	282.2944	13	21.7150	3.0537	0.0002
GEAR$	332.8477	4	83.2119	11.7016	0.0000
SUB_REGION$	518.3715	8	64.7964	9.1120	0.0000
SEASON$	26.4886	2	13.2443	1.8625	0.1553
MESH$	244.0847	2	122.0423	17.1621	0.0000
Error	105372.8981	14818	7.1111		

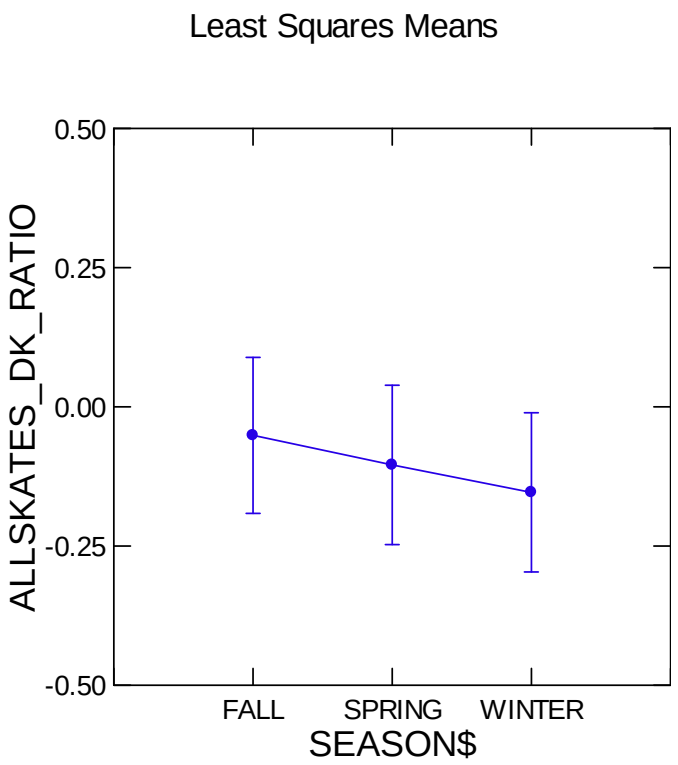
Estimates of Effects $B = (X'X)^{-1}X'Y$		
Factor	**Level**	**ALLSKATES_DK_RATIO**
CONSTANT		0.5507
YEAR$	1994	-0.4975
YEAR$	1995	-0.4047
YEAR$	1996	-0.4169
YEAR$	1997	-0.4944
YEAR$	1998	-0.4748
YEAR$	1999	-0.5144
YEAR$	2000	-0.2394
YEAR$	2001	-0.6300
YEAR$	2002	-0.4004
YEAR$	2003	-0.3571
YEAR$	2004	-0.3743
YEAR$	2005	-0.3498
YEAR$	2006	-0.2432
GEAR$	Other	-0.4991
GEAR$	Shrimp trawl	-0.0567
GEAR$	Sink gillnet	-0.3809
SUB_REGION$	Delmarva	0.1714
SUB_REGION$	E. GB	0.2404
SUB_REGION$	E. GM	-0.3755
SUB_REGION$	NY Bight	0.4924
SUB_REGION$	Offshore	-0.0499
SUB_REGION$	Other	0.2337
SUB_REGION$	S. Channel	0.0072
SUB_REGION$	SNE	0.4252
MESH$	Large	0.2542
MESH$	Small	-0.0982
SEASON$	FALL	0.1023
SEASON$	SPRING	0.0493


Least Squares Means
ALLSKATES_DK_RATIO
0.50
0.25
0.00
-0.25
-0.50
-0.75
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR$


Least Squares Means
ALLSKATES_DK_RATIO
0.75
0.50
0.25
0.00
-0.25
Other
Shrimp trawl
Sink gillnet
Trawl
GEAR$


Least Squares Means
ALLSKATES_DK_RATIO
0.5
0.2
-0.1
-0.4
-0.7
-1.0
Delmarva
E. GB
E. GM
NY Bight
Offshore
Other
S. Channel
SNE
W. GM
SUB_REGION$


Least Squares Means
ALLSKATES_DK_RATIO
0.50
0.25
0.00
-0.25
-0.50
Large
Small
Very large
MESH$



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