Appendix II

2012-2013 Skate Complex Acceptable Catch Limit Recommendations

Skate Plan Development Team Report
May 2011

1.0 Executive Summary

The objective of this Skate Plan Development Team (PDT) document is to update data and identify 2012-2013 specifications, responding to changes in the fishery and resource. Updated data include 2008-2010 mean stratified survey biomass for seven managed skate species, fishing year 2010 landings, calendar year 2008-2010 discards, and new discard mortality estimates.

Amendment 3, which established ACL specifications to limit skate catches, was implemented July 16, 2010. Amendment 3 implemented 2010 and 2011 ACL specifications, established a 20,000 lb. skate bait possession limit, reduced the skate wing possession limit to 5,000 lbs., established a 500 lbs. (wing weight) incidental skate possession limit, established in-season and post-season accountability measures, and established a two-year specification cycle. This document is the first step in establishing 2012-2013 specifications to comply with the procedures established by Amendment 3.

Since Amendment 3 implementation, the skate wing fishery reached 80% of the TAL earlier than anticipated, which triggered a reduction in the skate wing possession limit to the incidental limit on September 3, 2010. This early closure of the skate wing fishery had significant economic effects and the Council reacted by submitting Framework Adjustment 1 based on input from the fishing industry. Framework 1 became effective on May 17, 2011 and reduces the 5,000 lbs. skate wing possession limit to 2,600 lbs. from May 1 to August 31 and to 4,100 lbs. from September 1 to April 30, provided the AM trigger is not exceeded before the end of the fishing year. Framework 1 also increases the skate wing fishery TAL trigger from 80% to 85%, but the 500 lbs. incidental skate wing limit was not changed.

The 2009-2010 survey data were calibrated to FSV Albatross units according to Method 1, approved by the SSC for setting ACL specifications and the catch biomass median reference points were adjusted to account for consistent survey strata. Increases in little and winter skate biomass were the primary drivers of the change in ACL specifications proposed in this document.

ACL specifications were calculated using formulae and procedures approved by the SSC in January 2009, following the 2008 Data Poor Assessment Workshop (DPWS). Updated landings and discard estimates were allocated to species using the selectivity ogive method, approved by the DPWS.

New research on commercial trawl vessels in the Gulf of Maine indicate that little and winter skate discard mortality rates are less than formerly assumed. Accounting for the fraction of skate catch associated with trawl fishing and species composition, the weighted average discard mortality rate was estimated to be 0.31 in 2010. This lower mortality assumption applies to the entire time series, lowers the little and winter skate catch/biomass median values, reduces the ABC estimate and the fraction of the ACT which is assumed to be discarded dead in 2012-2013. The final analysis (analysis F in Table 16) estimates the ABC at 50,435 mt, the ACT at 37,826 mt (75% of the ABC to account for management uncertainty), and the TAL at 24,088 mt. The specifications from analysis F including the proposed skate mortality rate assumption, transfers at sea in skate landings, and updated discard rates and survey biomass is proposed by the PDT for the 2012-2013 specifications.

Section 10.0 provides a stochastic estimate of the precision of the ABC estimate, incorporating scientific uncertainty about the ABC reference points (i.e. catch/biomass medians) and about the survey biomass estimates (including uncertainty in the calibration coefficient). Risk (i.e. the probability of overfishing and its consequences) is harder to interpret, however, largely because there is no skate OFL in terms of mortality or catch.

The following acronyms are used commonly throughout the document, using definitions described in the Magnuson Fishery Conservation and Management Act (MSA), as amended:

ABC – Acceptable Biological Catch
ACL – Annual Catch Limit
ACT – Annual Catch Target
AM – Accountability Measure
B_{msy} – Biomass that would produce MSY when fished at F_{msy}
DPWS – Data Poor Assessment Workshop, a benchmark assessment of the skate complex conducted in December 2008 (http://www.nefsc.noaa.gov/saw/datapoor/)
F_{msy} – a fishing mortality rate that produces MSY when biomass is at B_{msy}
MSY – Maximum sustainable yield
OFL – Overfishing Level
TAL – Total Allowable Landings

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3.0 Survey biomass

The ACL specifications are derived from the most recent three year average of stratified mean survey biomass from the spring (for little skate) and fall trawl surveys (Table 1), following a formula approved by the SSC and implemented in Amendment 3. When updated, for a new year of data, the earliest value is dropped and the newest value is added to the average, so that changes in the applied biomass value arise from omitting earlier data and adding newer data. The survey value used in the ABC calculation may change as much from the omission of older data as from the addition of newer data in the three year average.

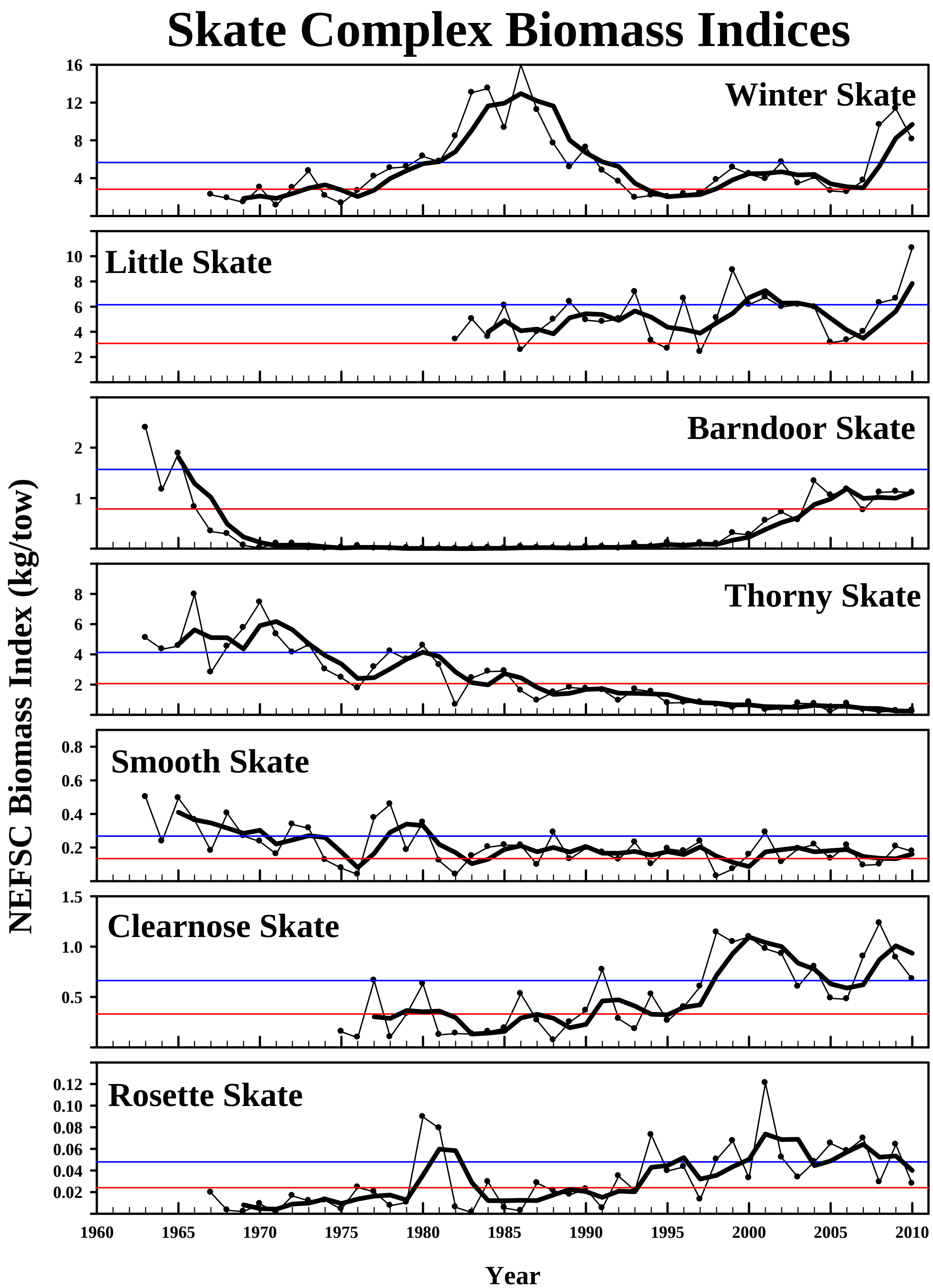
The largest changes in three year mean biomass occurred for little, thorny, and winter skates. Increases in the little and winter skate three year moving averages account for the most influence on the ABC, because the majority of catches are attributable to these two species. The three year average little skate biomass increased by 73 percent from 4.54 to 7.85 kg/tow, because the low 2006 and 2007 values were replaced by much higher 2009 and especially 2010 values. Similarly, the low winter skate biomass values in 2006 and 2007 were replaced by much higher values in 2009 and 2010. The three year average increased by 83 percent from 5.29 to 9.68 kg/tow. Thorny skate biomass has been trending downward for nearly the entire time series and continues to do so. The three year average biomass declined from 0.42 to 0.25 kg/tow, but because thorny skate account for a relatively small fraction of historic catch, this change has little influence on the ABC estimate. Barndoor, clearnose, and rosette three year average biomass values were nearly the same as those applied in Amendment 3 to estimate 2010-2011 ABC values.

Trends in skate survey stratified mean biomass are graphed in Figure 1. According to the most recently available data from 2010, the only overfished skates are smooth and thorny. Biomass for clearnose, little, rosette, and winter are above the target value. In fact the three year (2008-2010) moving average for little skate is a time series record high. Following a series of years when winter skate biomass was near the threshold, biomass increased above the threshold in 2008, 2009, and 2010. Barndoor skate biomass is above the threshold but below the target, and is therefore not overfished nor rebuilt.

Table 1. Annual and three year average spring (little) and fall skate stratified mean biomass survey weight per tow (kg/tow). The 2006-2008 data were collected by the FSV Albatross, while the 2009-2010 data were collected to the FSV Bigelow and converted using accepted calibration coefficients by species (Method 1). Source: Northeast Fisheries Science Center.

	Barndoor	Clearnose	Little	Rosette	Smooth	Thorny	Winter
2006	1.17	0.48	3.33	0.06	0.21	0.74	2.52
2007	0.76	0.90	4.01	0.07	0.09	0.32	3.74
2008	1.11	1.23	6.29	0.03	0.10	0.20	9.62
2009	1.13	0.89	6.62	0.06	0.21	0.25	11.33
2010	1.10	0.68	10.63	0.03	0.18	0.28	8.09
Three year averages							
2006-2008	1.013	0.871	4.541	0.052	0.135	0.420	5.294
2007-2009	0.999	1.009	5.639	0.053	0.133	0.258	8.232
2008-2010	1.114	0.933	7.848	0.040	0.161	0.245	9.684

Figure 1. NEFSC survey biomass indices (kg/tow. Thin lines with symbols are annual indices, thick lines are 3-year moving averages, and the thin horizontal lines are the biomass thresholds using consistent FSV Albatross/Bigelow strata.



4.0 Landings

4.1 Wing and bait fishery monitoring

Landings through April 30, 2011 (the end of the 2010 fishing year) were updated in this report to determine whether AMs would be triggered and to update the discard rate to 2008-2010 (landings are needed to estimate total catch). Landings are monitored in-season by the NMFS Northeast Regional Office and published weekly on their website (see figures below), determining whether in-season accountability measures (changes to skate possession limits) are warranted. The landings are monitored separately for the skate wing (sold as food) and skate bait (primarily sold as lobster bait) fisheries which target different skate species based on size. The weekly monitoring reports include landings by all vessels, whether or not they hold a federal permit at the time of landing.

Skate wing landings in fishing year 2010 by vessels holding federal permits totaled 19.4 million pounds or 8,792 mt. This was 95% of the 9,209 mt TAL (Table 2). Skate bait landings were determined from the disposition code supplied by dealers and totaled 8.8 million pounds or 3,988 mt by vessels holding a federal permit at the time of landing skates. This was 86% of the 4,639 mt TAL.

Landings by vessels not having a federal permit, were assumed to occur from vessels with state permits fishing in state waters. The landings by these vessels totaled 4.1 million pounds or 1,852 mt., which was 12.6% of total skate landings. Analysis of 2007-2009 data in Amendment 3 indicated that skate landings by state vessels in state waters totaled 924 mt, or 3% of total skate landings. The methods in the Amendment 3 analysis differed from the monitoring methods that were actually implemented, however, probably contributing to the unexpected increase in state landings. In the Amendment 3 analysis, any dealer report of skate landings for vessels with permit numbers were assumed to be landings by federal vessels (whether or not the vessel actually had a permit at the time of landing). Only landings with ‘permit’ number ‘190998’ and ‘390998’, known to be aggregate state dealer landings for undertonnage and tonnage vessels were assigned to the state landings category.

That being said, there were anecdotal reports that some fishermen in Southern New England switched to fishing with non-federal vessels to continue fishing for skates after the skate wing possession limit dropped from 5,000 lbs. to 500 lbs. on September 3, 2010.

Figure 2. Final landings monitoring report for the 2010 skate wing fishery. Source: NMFS, NE Regional Office.

Northeast Skate Complex Wing Fishery Weekly Report

For week ending: April 30, 2011
For data reported through: May 5, 2011
Quota Period: 2010
Quota Period Dates: 05/01/10 to 04/30/11

Previously Reported Landings (Whole Pounds)	Previous Weeks' Updates (Whole Pounds)	Current Week's Landings (Whole Pounds)	Cumulative Landings (Whole Pounds)	Quota (Whole Pounds)	Percent of Quota (%)
21,738,765	*184,544*	*277,481*	*22,200,790*	*20,302,370*	*109*

Notice

Effective 0001 hours on September 3, 2010, fishing vessels issued a Federal open access skate permit may not possess or land more than the incidental limit of 500 lb of skate wings (1,135 lb whole weight) per trip for the remainder of the 2010 fishing year (through April 30, 2011).

National Oceanic and Atmospheric Administration

These data are the best available to NOAA Fisheries Service when this report was compiled. Data are supplied to NOAA Fisheries Service by dealers via Dealer Electronic Reporting to the Standard Atlantic Fisheries Information System (SAFIS) and/or by state agencies and may be preliminary. Discrepancies with data from previous Weekly Landings Reports are due to corrections made to the database.

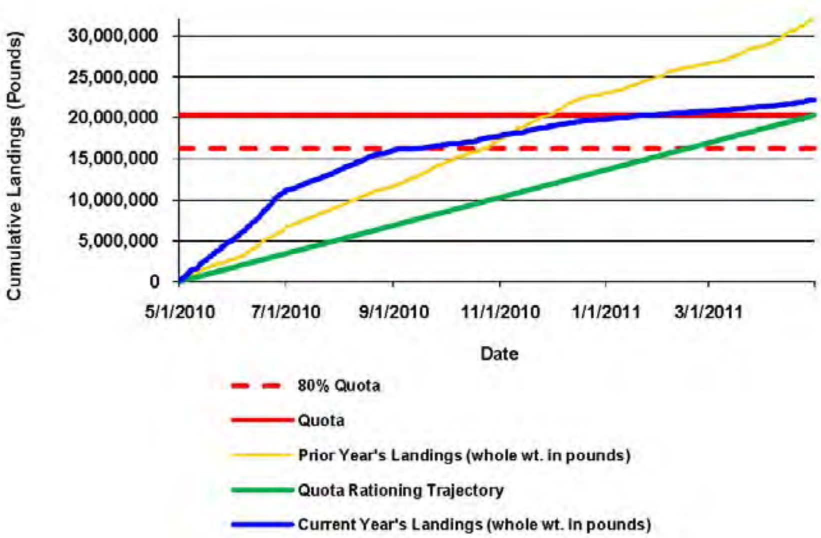


Figure 3. Final landings monitoring report for the 2010 skate bait fishery. Source: NMFS, NE Regional Office.

Northeast Skate Complex Bait Fishery Weekly Report

For week ending: April 30, 2011
For data reported through: May 5, 2011
Quota Period: Annual
Quota Period Dates: 05/01/10 to 04/30/11

Previously Reported Landings (Pounds)	Previous Weeks' Updates (Pounds)	Current Week's Landings (Pounds)	Cumulative Landings (Pounds)	Quota (Pounds)	Percent of Quota (%)
9,517,823	*324,567*	*106,708*	*9,949,098*	*10,227,224*	*97*

In-season adjustment of skate bait possession limits. When the Regional Administrator projects that 90 percent of the skate bait fishery seasonal quota has been landed in Seasons 1 or 2, or 90 percent of the annual skate bait fishery TAL has been landed, the Regional Administrator shall, through a notice in the Federal Register consistent with the Administrative Procedure Act, reduce the skate bait trip limit to the whole weight equivalent of the skate wing trip limit for the remainder of the quota period, unless such a reduction would be expected to prevent attainment of the seasonal quota or annual TAL.

National Oceanic and Atmospheric Administration

These data are the best available to NOAA Fisheries Service when this report was compiled. Data are supplied to NOAA Fisheries Service by dealers via Dealer Electronic Reporting to the Standard Atlantic Fisheries Information System (SAFIS) and/or by state agencies and may be preliminary. Discrepancies with data from previous Weekly Landings Reports are due to corrections made to the database.

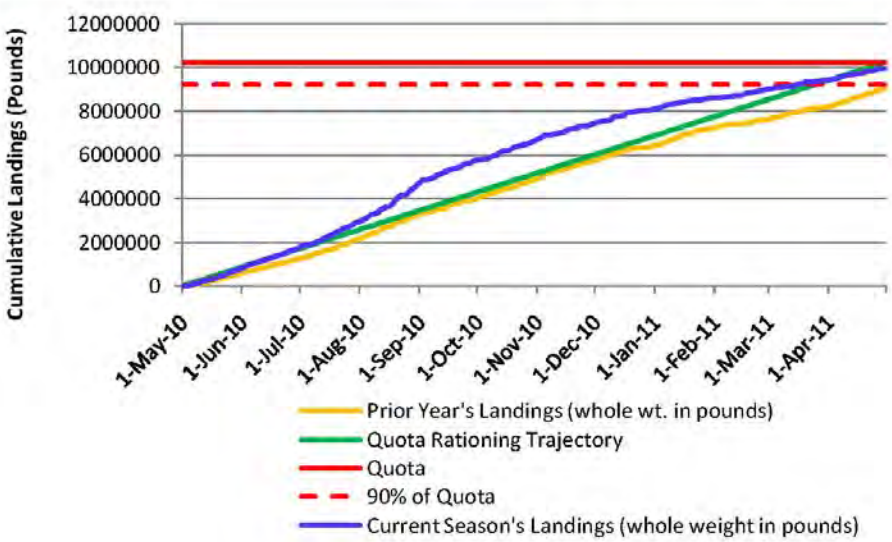


Table 2. Skate complex landings by fishery and estimated discards for fishing year 2010. Federal landings are defined as landings by vessels which hold any federal permit on the landing date. Transfers at sea are reported skate landings sold to dealer '000002', designating that the fish had been sold to another vessel at sea, presumably for bait. Discards are estimated on a calendar year basis due to data processing procedures, assuming a 50% discard mortality rate that was assumed in setting 2010 specifications. Source, NMFS Northeast Regional Office using reports from dealers via electronic reporting and the NMFS permit data base.

	Federal	Federal (mt)	State	State (mt)	%Federal	%State	Total	Total (mt)	TAL (mt)	Percent of TAL/ACL
Wings	19,382,854	8,792	2,850,052	1,293	87.1	12.8	22,241,698	10,089	9,209	95
Bait	8,792,771	3,988	1,231,847	559	87.7	12.3	10,028,606	4,549	4,639	86
Total Landings (A	28,175,625	12,780	4,081,899	1,852	87.3	12.6	32,270,304	14,638		36
Transfers at sea (B)							3,595,351	1,631		4
Estimated dead discards (C)							41,389,321	18,774		46
ACL							90,565,872	41,080		85

4.2 Transfers at sea

An additional source of mortality was discovered during the recent whiting assessment, reports of transfers at sea on vessel trip reports (VTRs). Skates were by far the highest amounts reported in this manner and comprise a significant portion of the total catch (see table below). These 'landings' were not recognized in the Amendment 3 analyses and were not included in the estimation of ABC or TAL.

After investigating these data in more detail, the PDT decided that they should be added to the catch time series, attributed to species composition according to the DPWS procedures for the skate bait fishery, and in the future monitored against the bait fishery TAL. The reported transfers at sea for all species (not just skates) were also included in the expansion of the observed D/K-all ratios to estimate total skate discards (stratified by gear, region, and quarter). Accordingly, the revised skate discard rate with the transfers at sea multiplier should also be included assumed future discard rates to estimate TAL.

Skate transfers at sea peaked at 15.2 million pounds in 1999, declined to 2.9 to 6.4 million pounds in 2003-2009, then declined to 3.6 million pounds in 2010. It is unclear why skate transfers at sea declined in 2010, possibly because of skate bait marketing changes under the new ACL management.

Table 3. Total skate 'landings' reported on VTRs for dealer='000002', designating transfers at sea to another vessel, presumably for lobster bait. Most of these reported transfers occur in Southern New England waters from vessels fishing out of MA, RI, and CT ports.

Calendar year	Trips.	Total QtyKept (lbs.)	Total QtyKept (mt)
1994	350	3,002,658	1,362
1995	338	3,354,206	1,521
1996	504	5,848,874	2,653
1997	732	7,412,444	3,362
1998	1012	10,598,440	4,807
1999	1216	15,245,292	6,915
2000	1075	11,674,476	5,295
2001	899	12,063,896	5,472
2002	687	7,311,580	3,316
2003	915	5,426,885	2,462
2004	991	4,036,078	1,831
2005	773	2,861,148	1,298
2006	910	4,143,399	1,879
2007	1171	4,741,115	2,151
2008	954	5,147,572	2,335
2009	1278	6,373,561	2,891
2010	927	3,595,351	1,631

5.0 Discard estimates

Discards were estimated for calendar year 2010 by gear and half-year (see table below). Discards are estimated for a calendar year, rather than the fishing year, because they rely on the NMFS area allocation landings tables to expand observed discard/kept-all (D/K-all) ratios to total based on landings by gear, area, and quarter. The observed D/K-all ratios were derived from the Sea Sampling Observer and the At Sea Monitoring programs and included both sector and non-sector vessels, but were not stratified on that basis. Analysis of the two data sources indicated that the D/K-all ratios were similar for data derived from the two programs.

These area allocation tables are prepared annually from dealer and vessel trip report records after these data have become final, and are usually available after April 1 following the end of the calendar year. This procedure makes it impossible at this time to include the January to April 2011 period, as a fishing year estimate.

Total estimated discards for 2010 were 37,548 mt (see table below). Discards increased by 6.7% over the 2009 estimates. Some of the increase may have occurred due to the lower skate wing possession limit, particularly from September 3 to December 31, 2010 when the possession limit was 500 lbs. Changes in the estimated discards may also have been mitigated by reduced landings and effort by multispecies (groundfish) sector vessels.

Discard estimates from the Data Poor Stocks Working Group were updated and errors in the tables corrected. The ratio-estimator used in this assessment is based on the methodology described in Rago et al. (2005) and updated in Wigley et al 2007. It relies on a d/k ratio where the kept component is defined as the total landings of all species within a "fishery". A fishery is defined as a homogeneous group of vessels with respect to gear type (longline, otter trawl, shrimp trawl, sink gill net, and scallop dredge), quarter (months 1-4, 5-6, 7-8, 9-12), and area fished (GOM, GB, SNE, MA). Mesh size was not used to split out otter trawl trips or sink gill net trips. All trips were included if they occurred within this stratification regardless of whether or not they caught skates.

The discard ratio for skates in stratum h is the sum of discard weight over all trips divided by sum of kept weights over all trips:

$$\hat{R}_h = \frac{\sum_{i=1}^{n_h} d_{ih}}{\sum_{i=1}^{n_h} k_{ih}} \qquad (1)$$

where d_{ih} is the discards for skates within trip i in stratum h and k_{ih} is the kept component of the catch for all species. R_h is the discard rate in stratum h. The stratum weighted discard to kept ratio is obtained by weighted sum of discard ratios over all strata:

$$\hat{R} = \sum_{h=1}^{H} \left(\frac{N_h}{\sum_{h=1}^{H} N_h} \right) \hat{R}_h \qquad (2)$$

The total discard within a strata is simply the product of the estimate discard ratio R and the total landings for the fishery defined as stratum h, i.e., $D_h=R_hK_h$. The total landings were updated to include landings of all species sold over-the-side as bait.

Missing cells were imputed using averages of existing cells. If information existed in the same area fished, the annual average discard ratio was applied in the missing cells. If the information was missing in the area fished, but available in the region (i.e. SNE and MA or GOM and GBK), then the annual average for that region was applied. There were some cases for the longline fishery in which the entire year was averaged for all areas or for a span of 12 years (1993-2004).

To hindcast the discard estimates back to 1964, a three-year average (the earliest three years of data) of the discards of skates/landings of all species was used. Estimated discards by fishery, region and half year for 1964-2010 are summarized in Table 4 to Table 6.

5.1 Discards by Species Estimation

The discard estimates were not dis-aggregated to skate species in previous assessments because identification of skates is uncertain in the Fisheries Observer Program (NEFSC 2007). The observer lengths of the discarded component of the catch were used by gear type. The data were apportioned into two regions, Gulf of Maine to Georges Bank (GOMGBK – Divisions 51 and 52), and Southern New England to Mid-Atlantic (SNEMA – Divisions 53 and Subarea 6). The number of fish measured in these regions was barely sufficient (Table 7) so no further areal division was attempted. Pooling over years, sometimes over the entire time series, within a region was still required to get an adequate number of fish (Figure 4). For longline gear, all samples were used for both regions. An average skate length-weight equation was applied to the samples and used to estimate the discard numbers at length by gear category

Length compositions from the NEFSC spring and autumn survey for each species for the two regions (GOMGBK – Offshore strata 13-30, 36-40, and Inshore strata 56-66; SNEMA – Offshore strata 1-12, 61-76, and Inshore strata 1-55) were estimated. The species length-weight equations were then applied to determine weight-at-length by species. The proportions at length by species for both number and weight were applied to the commercial landings-at-length to estimate landings-at-length by species. The lengths had to be grouped into 5 cm intervals to avoid zero cells in the survey and all fish greater than 112 cm were set to be barndoor skate. To estimate the species composition from 1968-1995, the proportion by weight in the spring and autumn surveys in four regions (GOM, GBK, SNE, and MA) was applied to the discard estimates by gear type. The estimates by gear type and species are given in Table 8 to Table 11.

5.2 2010 Comparison

In 2010, Amendment 16 to the Northeast Multispecies (Groundfish) Management Plan required an increase in observer coverage to monitor discards of groundfish. This was done with At-Sea-Monitors (ASM), whose responsibilities were slightly different than for regular observers (OB). A comparison was made between the discard rates of these ASM trips and OB trips. Figure 5 shows the difference between the discard rates of the two types of trips as well as the number of trips covered under each program (ASM and SSOP) for different gear/quarter/region combinations. Given that most of the rates are similar, using these data should not bias the discard estimates. A comparison was also made between these groundfish trips, and non-groundfish trips using the same gear in the same time period and region (Figure 5). These were also similar enough to be combined in a single analysis of skate discards, with the larger differences between the two sampling programs that appear to result from low sample sizes for non-groundfish trips (Figure 6).

A final comparison for 2010 was between "otter" trawl, the "Ruhle" trawl and the "haddock separator" trawl to see if these three gear types could be combined. Table 12 shows the discard to kept ratios, the mt in the dealer database as well as the number of trips observed and in the dealer database. The ratios of the three gears are different. However, it appears that not all records in the database have the correct gear type, given that the number of trips observed is almost equal to the number of trips in the dealer database for the Ruhle and haddock separator trawls. Therefore, the PDT decided to include the Ruhle and haddock separator trawls in the otter trawl category at this time.

Table 4. Estimated discards (mt) of skates (all species) by gear type taken in the Gulf of Maine-Georges Bank region, 1964-2010.

			Half 1						Half 2				
Year	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 1	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 2	Grand Total
1964	441	37,255	0	12	5,882	43,589	471	22,824	0	7	6,539	29,841	73,430
1965	491	38,321	0	17	2,294	41,123	609	24,329	0	5	599	25,541	66,663
1966	373	39,624	0	26	751	40,773	572	22,374	0	7	1,504	24,458	65,231
1967	318	30,462	0	22	582	31,383	379	19,148	0	8	2,294	21,829	53,212
1968	252	26,067	0	37	737	27,093	345	18,036	0	10	1,649	20,040	47,134
1969	272	25,173	0	32	1,011	26,488	523	15,909	0	6	1,934	18,372	44,860
1970	298	22,927	0	22	1,234	24,481	479	15,208	0	7	1,887	17,582	42,062
1971	458	21,746	0	21	1,767	23,993	715	14,941	0	8	1,452	17,116	41,108
1972	462	19,491	0	31	1,248	21,233	765	12,401	0	13	1,715	14,894	36,126
1973	553	19,548	0	31	1,793	21,924	749	13,558	0	15	1,496	15,818	37,743
1974	593	17,687	0	58	1,060	19,398	691	11,947	0	24	1,410	14,071	33,469
1975	660	15,631	280	61	1,327	17,959	713	11,792	37	26	2,025	14,593	32,552
1976	450	15,157	66	99	1,677	17,449	407	12,139	0	37	3,113	15,696	33,145
1977	332	19,662	39	169	3,321	23,524	338	14,148	0	47	7,174	21,707	45,230
1978	539	23,070	0	189	4,030	27,829	372	14,383	0	66	7,886	22,707	50,535
1979	741	22,771	26	156	5,292	28,986	593	16,612	0	67	8,446	25,719	54,704
1980	816	28,570	21	189	7,424	37,020	183	18,066	0	96	6,969	25,314	62,333
1981	325	29,786	99	258	8,268	38,735	114	15,643	0	93	9,497	25,347	64,082
1982	293	26,789	124	91	5,650	32,948	86	19,496	7	83	7,923	27,595	60,544
1983	282	29,695	115	116	4,847	35,055	106	16,467	22	69	5,650	22,314	57,369
1984	294	27,882	152	123	3,515	31,967	22	13,640	53	94	4,352	18,161	50,128
1985	252	22,242	225	115	2,350	25,184	60	10,748	70	81	4,717	15,676	40,860
1986	309	19,142	252	170	4,036	23,908	58	8,856	83	87	6,203	15,288	39,196
1987	510	15,330	288	140	3,927	20,196	193	8,272	46	85	7,568	16,165	36,361
1988	536	17,091	183	162	6,206	24,177	230	8,410	46	90	9,991	18,767	42,944
1989	481	18,497	73	48	6,392	25,491	185	8,727	17	92	11,097	20,118	45,609
1990	343	23,476	208	347	7,324	31,699	182	9,910	71	73	15,213	25,449	57,147
1991	1,064	11,624	243	99	9,870	22,900	260	8,680	44	113	10,371	19,468	42,368
1992	1,285	8,056	247	162	8,930	18,680	727	2,848	0	56	10,931	14,562	33,243
1993	57	4,528	35	119	4,541	9,279	22	11,482	1	65	4,951	16,520	25,799
1994	14	4,912	11	130	2,278	7,346	25	10,153	1	72	2,026	12,277	19,623
1995	25	7,492	8	209	397	8,130	26	2,317	1	259	1,647	4,249	12,380
1996	21	7,509	26	284	820	8,660	21	1,189	8	65	3,002	4,285	12,944
1997	20	3,683	34	110	1,832	5,679	21	3,571	4	16	3,193	6,805	12,484
1998	17	4,228	6	50	2,595	6,897	24	15,062	0	56	4,110	19,254	26,151
1999	19	2,840	3	98	1,235	4,195	21	7,197	0	110	2,966	10,295	14,489
2000	11	4,495	4	121	1,975	6,605	22	7,605	0	740	1,375	9,742	16,347
2001	15	19,283	0	188	514	19,999	16	6,275	0	153	554	6,998	26,997
2002	17	11,100	1	135	923	12,176	42	5,784	0	199	2,023	8,047	20,223
2003	32	11,689	8	253	1,820	13,803	4	9,858	0	153	1,962	11,977	25,780
2004	3	11,512	4	269	271	12,059	10	13,838	0	218	1,017	15,083	27,143
2005	91	9,468	2	399	594	10,554	54	12,851	0	204	2,212	15,321	25,875
2006	193	8,043	0	173	1,070	9,480	17	9,350	1	294	2,407	12,069	21,549
2007	46	10,708	0	378	872	12,005	27	11,205	0	363	3,419	15,013	27,018
2008	62	5,919	2	149	1,594	7,725	17	7,959	0	302	2,175	10,452	18,177
2009	56	6,784	1	538	905	8,284	46	11,295	0	198	902	12,441	20,725
2010	143	7,393	0	94	296	7,926	46	9,038	0	274	1,043	10,402	18,328

Table 5. Estimated discards (mt) of skates (all species) by gear type taken in the Southern New England-Mid-Atlantic region, 1964-2010.

			Half 1					Half 2			
Year	Line Trawl	Otter Trawl	Sink Gill Net	Scallop Dredge	Total Half 1	Line Trawl	Otter Trawl	Sink Gill Net	Scallop Dredge	Total Half 2	Grand Total
1964	0	16,916	0	1	16,917	0	12,929	0	488	13,416	30,333
1965	0	20,746	0	2,120	22,866	0	15,053	0	7,230	22,283	45,149
1966	0	23,680	0	5,327	29,007	0	11,657	0	3,998	15,655	44,662
1967	0	26,886	0	2,362	29,248	0	13,933	0	1,741	15,674	44,923
1968	0	30,741	0	3,069	33,810	0	13,895	0	2,474	16,369	50,179
1969	2	30,557	0	1,349	31,907	1	11,827	0	673	12,501	44,408
1970	2	21,694	0	394	22,090	0	10,272	0	454	10,726	32,815
1971	2	13,419	0	93	13,514	0	4,979	0	747	5,726	19,240
1972	2	13,272	0	734	14,009	1	6,373	0	478	6,852	20,861
1973	13	15,425	0	413	15,851	4	6,227	0	170	6,402	22,253
1974	34	19,170	0	692	19,895	13	5,279	0	968	6,260	26,155
1975	34	9,882	0	1,062	10,978	13	5,131	0	2,025	7,169	18,147
1976	19	7,688	0	2,225	9,933	11	7,804	0	3,906	11,721	21,653
1977	10	7,639	0	3,388	11,038	4	7,169	0	1,323	8,496	19,534
1978	214	12,605	0	3,969	16,788	192	8,389	0	4,140	12,721	29,509
1979	97	16,229	0	3,530	19,857	191	10,770	0	2,880	13,841	33,698
1980	193	11,730	0	2,384	14,307	156	10,958	0	2,318	13,432	27,739
1981	203	13,828	0	1,121	15,152	158	10,028	0	964	11,149	26,301
1982	134	17,088	0	1,634	18,857	88	17,764	0	2,661	20,512	39,369
1983	114	20,196	0	3,811	24,121	76	15,883	0	4,417	20,376	44,498
1984	91	21,023	0	5,179	26,293	54	17,034	0	3,985	21,073	47,366
1985	63	18,452	0	4,442	22,956	83	12,401	0	3,171	15,655	38,611
1986	112	18,225	0	3,272	21,609	91	17,119	0	4,053	21,263	42,873
1987	116	21,129	0	8,591	29,835	95	15,105	0	8,355	23,555	53,391
1988	90	18,544	0	8,176	26,810	17	13,960	0	6,268	20,245	47,054
1989	55	19,166	0	13,218	32,439	26	11,537	0	5,279	16,843	49,282
1990	41	26,989	0	11,014	38,044	34	25,810	0	4,600	30,444	68,489
1991	110	11,258	0	8,638	20,006	63	21,176	0	5,478	26,717	46,723
1992	361	5,097	107	5,628	11,194	377	16,761	51	7,157	24,346	35,540
1993	13	3,466	93	5,329	8,900	6	10,309	45	7,217	17,577	26,478
1994	6	60,588	135	3,821	64,550	3	6,148	155	3,030	9,336	73,886
1995	3	15,501	234	8,336	24,074	4	9,385	91	18,198	27,677	51,752
1996	7	8,089	135	7,540	15,771	6	24,611	66	8,466	33,149	48,920
1997	10	2,950	282	9,230	12,471	8	3,213	76	3,141	6,438	18,910
1998	8	22,495	167	4,223	26,893	9	5,074	195	4,334	9,612	36,505
1999	4	970	500	5,959	7,433	3	2,430	139	4,989	7,560	14,993
2000	3	2,422	60	3,233	5,719	4	9,435	53	3,335	12,826	18,545
2001	5	1,861	216	3,253	5,336	6	2,163	52	2,695	4,916	10,252
2002	4	1,076	256	5,165	6,501	65	3,880	2,265	5,674	11,883	18,385
2003	6	6,226	269	6,093	12,594	6	8,204	290	6,107	14,606	27,200
2004	6	2,911	181	4,960	8,059	1	7,847	280	3,060	11,188	19,246
2005	0	4,718	638	5,485	10,840	0	6,345	355	2,401	9,100	19,941
2006	2	2,551	686	4,658	7,897	0	2,966	68	2,527	5,562	13,459
2007	0	4,047	663	4,924	9,635	0	5,566	408	3,804	9,778	19,413
2008	49	4,748	1,172	3,479	9,448	48	4,745	406	2,764	7,963	17,411
2009	76	3,745	913	3,148	7,882	129	3,785	339	2,335	6,588	14,470
2010	125	2,040	963	7,786	10,915	163	2,831	1,070	4,240	8,304	19,219

Table 6. Estimated discards (mt) of skates (all species) by gear type, 1964-2010

			Half 1						Half 2				
Year	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 1	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Total Half 2	Grand Total
1964	441	54,171	0	12	5,883	60,506	471	35,752	0	7	7,027	43,258	103,763
1965	491	59,067	0	17	4,414	63,989	609	39,381	0	5	7,829	47,824	111,812
1966	373	63,304	0	26	6,078	69,781	572	34,031	0	7	5,502	40,112	109,893
1967	319	57,348	0	22	2,944	60,631	379	33,081	0	8	4,035	37,504	98,135
1968	252	56,808	0	37	3,807	60,904	345	31,931	0	10	4,123	36,409	97,313
1969	273	55,730	0	32	2,359	58,395	524	27,736	0	6	2,607	30,873	89,268
1970	299	44,621	0	22	1,628	46,570	479	25,480	0	7	2,341	28,308	74,878
1971	460	35,165	0	21	1,860	37,506	715	19,920	0	8	2,199	22,842	60,348
1972	464	32,764	0	31	1,982	35,241	766	18,774	0	13	2,193	21,746	56,988
1973	566	34,973	0	31	2,206	37,776	754	19,785	0	15	1,666	22,220	59,996
1974	627	36,856	0	58	1,752	39,293	703	17,226	0	24	2,377	20,331	59,624
1975	695	25,513	280	61	2,389	28,937	726	16,923	37	26	4,050	21,762	50,699
1976	470	22,845	66	99	3,902	27,382	418	19,943	0	37	7,019	27,417	54,798
1977	343	27,301	39	169	6,710	34,561	342	21,317	0	47	8,497	30,203	64,764
1978	754	35,675	0	189	7,999	44,617	564	22,772	0	66	12,026	35,428	80,045
1979	838	39,000	26	156	8,822	48,843	785	27,382	0	67	11,326	39,559	88,402
1980	1,009	40,300	21	189	9,808	51,326	338	29,024	0	96	9,288	38,746	90,072
1981	527	43,614	99	258	9,389	53,887	272	25,671	0	93	10,461	36,496	90,383
1982	427	43,877	124	91	7,285	51,805	173	37,260	7	83	10,584	48,108	99,913
1983	396	49,891	115	116	8,658	59,176	182	32,350	22	69	10,066	42,690	101,867
1984	386	48,904	152	123	8,694	58,260	76	30,674	53	94	8,337	39,234	97,494
1985	315	40,693	225	115	6,791	48,140	143	23,149	70	81	7,888	31,331	79,471
1986	421	37,367	252	170	7,308	45,518	149	25,975	83	87	10,257	36,551	82,069
1987	626	36,459	288	140	12,518	50,031	288	23,377	46	85	15,924	39,720	89,752
1988	626	35,635	183	162	14,382	50,987	247	22,370	46	90	16,259	39,012	89,999
1989	536	37,663	73	48	19,609	57,930	211	20,264	17	92	16,377	36,961	94,890
1990	385	50,465	208	347	18,338	69,743	216	35,720	71	73	19,813	55,893	125,636
1991	1,174	22,882	243	99	18,508	42,906	323	29,856	44	113	15,850	46,185	89,091
1992	1,646	13,153	247	269	14,558	29,874	1,105	19,609	0	107	18,088	38,909	68,783
1993	69	7,994	35	212	9,869	18,180	27	21,791	1	110	12,168	34,097	52,277
1994	20	65,500	11	265	6,099	71,896	28	16,301	1	228	5,056	21,613	93,509
1995	28	22,993	8	443	8,733	32,205	30	11,701	1	350	19,845	31,927	64,132
1996	28	15,598	26	419	8,360	24,431	27	25,801	8	131	11,467	37,433	61,864
1997	30	6,633	34	392	11,061	18,151	30	6,784	4	91	6,334	13,243	31,393
1998	25	26,723	6	217	6,819	33,790	34	20,136	0	252	8,444	28,866	62,656
1999	23	3,810	3	599	7,194	11,628	24	9,627	0	249	7,955	17,854	29,482
2000	14	6,917	4	181	5,208	12,324	26	17,040	0	792	4,709	22,568	34,892
2001	20	21,144	0	404	3,767	25,335	22	8,439	0	204	3,249	11,914	37,249
2002	21	12,176	1	391	6,088	18,677	107	9,663	0	2,464	7,696	19,931	38,608
2003	38	17,915	8	522	7,913	26,397	10	18,061	0	443	8,068	26,582	52,980
2004	9	14,423	4	450	5,232	20,118	11	21,684	0	498	4,078	26,271	46,389
2005	91	14,186	2	1,037	6,079	21,395	54	19,196	0	559	4,613	24,421	45,816
2006	195	10,594	0	860	5,728	17,377	17	12,316	1	362	4,935	17,631	35,008
2007	46	14,755	0	1,041	5,796	21,640	27	16,771	0	771	7,222	24,791	46,431
2008	111	10,667	2	1,320	5,073	17,173	65	12,703	0	708	4,939	18,415	35,588
2009	132	10,530	1	1,451	4,053	16,165	176	15,080	0	537	3,237	19,030	35,195
2010	269	9,433	0	1,058	8,082	18,841	209	11,869	0	1,344	5,284	18,706	37,547

Table 7. Number of length samples by region, year, season, and gear type of the discarded component of the skate catch from the Northeast Fisheries Observer Program

GOMGBK										
		Half 1					Half 2			
YEAR	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge
1994			60						9	332
1995		726	9	55			90		37	
1996		626		17			107		7	45
1997		263	25		9		183		25	
1998				13	1499		60		213	
1999				52			77		18	48
2000		464		13	46		393		97	4
2001		1201		83			167		58	
2002		752		178			6089		224	762
2003	22	7508	186	564	12		6949		758	80
2004	41	6770	15	1710	654	56	8229		1758	1367
2005	74	19177	29	703	1042	13	12926		779	2124
2006	50	8096		460	440	35	8020		418	2949
2007	3	9376		393	1714	52	12468		1949	3514
2008	308	12704	26	386	1799	124	9658		525	2610
2009	11	4727		134	845	63	4013		296	799
2010	451	8084		665	374	310	6894		2455	2090

SNEMA										
		Half 1					Half 2			
YEAR	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge
1994			na				619	na	55	354
1995		261	na	698			500	na	12	
1996		19	na	347	379		247	na	0	0
1997		407	na	188	52		1323	na	46	179
1998		1	na	11	0		43	na	28	0
1999		0	na	78	0		0	na	10	0
2000		356	na	88	0		922	na	32	86
2001		942	na	72	0		1664	na	74	57
2002		190	na	370	0		1701	na	164	2125
2003	0	30	na	246	1525		520	na	1312	987
2004	0	1285	na	614	6762	0	2789	na	630	7546
2005	0	2423	na	745	2670	0	4285	na	762	2042
2006	24	808	na	61	0	1	1906	na	202	3844
2007	0	740	na	219	2819	0	1008	na	39	3819
2008	47	1480	na	738	8445	0	1961	na	140	5072
2009	0	1087	na	868	7135	0	2049	na	294	2216
2010	0	958	na	2161	4925		2875	na	562	3612

Figure 4. Pooling scheme used to derive the length composition of the discarded component of the skate catch.

Table 8. Estimates of discards by species from the longline fishery from 1968-2010.

Year	winter	little	longline barndoor	thorny	smooth	clearnose	rosette	Total
1968	216	110	18	235	19	0	0	597
1969	343	189	17	237	12	0	0	797
1970	332	124	3	304	16	0	0	779
1971	289	213	18	605	51	0	0	1175
1972	370	140	14	646	60	0	0	1230
1973	362	147	0	732	77	0	0	1320
1974	396	206	2	625	102	0	0	1330
1975	391	259	2	735	34	0	0	1421
1976	320	140	5	379	44	0	0	888
1977	253	81	0	315	35	0	0	684
1978	592	311	1	234	39	132	9	1317
1979	827	389	0	301	32	70	3	1623
1980	687	341	0	213	40	51	15	1347
1981	284	219	0	185	18	87	7	799
1982	276	224	0	90	5	5	0	601
1983	334	174	0	40	7	24	0	578
1984	300	110	0	30	1	15	5	462
1985	253	157	0	35	2	12	0	458
1986	343	112	0	43	4	68	0	570
1987	672	165	0	48	3	21	5	914
1988	675	145	0	41	5	2	4	873
1989	560	120	0	56	5	6	1	747
1990	367	132	0	78	8	14	1	600
1991	905	306	1	222	21	41	1	1497
1992	1463	806	17	365	31	54	14	2751
1993	41	28	0	25	3	0	0	97
1994	13	15	0	17	2	0	0	48
1995	40	6	4	5	1	1	0	58
1996	39	7	5	3	1	2	0	55
1997	36	8	9	4	1	3	0	60
1998	39	9	5	3	1	2	0	59
1999	33	7	5	1	0	1	0	47
2000	24	6	7	2	1	1	0	40
2001	24	8	7	1	1	2	0	42
2002	82	20	17	1	2	6	0	128
2003	29	9	6	2	2	1	0	48
2004	12	3	4	0	1	1	0	20
2005	70	19	39	6	11	0	0	145
2006	116	32	50	4	10	0	0	212
2007	36	11	23	1	2	0	0	73
2008	63	53	39	1	4	15	0	176
2009	181	79	29	1	3	15	0	307
2010	243	89	121	3	15	7	0	478

Table 9. Estimates of discards by species from the otter trawl and shrimp trawl fisheries from 1968-2010.

			otter trawl					
Year	winter	little	barndoor	thorny	smooth	clearnose	rosette	Total
1968	29746	35747	4116	17610	1423	35	62	88739
1969	29240	36787	1343	14412	895	780	9	83466
1970	21483	30043	884	15936	930	794	30	70101
1971	15430	20556	582	16328	1783	399	7	55085
1972	19276	16530	561	12950	1282	902	36	51538
1973	18019	19966	83	14378	1801	475	35	54758
1974	20645	17359	103	12949	2591	405	30	54082
1975	14048	16189	36	11682	643	122	33	42753
1976	13259	17041	146	10151	1119	837	301	42854
1977	19902	15173	1	11619	1110	796	55	48657
1978	29013	15807	27	9880	1734	1844	144	58447
1979	30018	23290	12	10310	1206	1504	68	66408
1980	38105	16454	2	11863	1919	759	242	69345
1981	39178	16476	2	11483	1037	1109	99	69384
1982	40881	30555	7	9051	502	243	31	81269
1983	46678	23986	1	8819	964	1909	22	82378
1984	41143	27779	5	8300	373	1572	613	79784
1985	34981	19051	3	9090	444	558	11	64137
1986	38507	11655	12	6690	587	6183	43	63677
1987	30425	19848	12	5314	365	3336	870	60170
1988	32188	19164	10	3938	583	247	2103	58234
1989	26173	26266	23	3527	367	1501	161	58017
1990	37105	36204	18	6548	700	5432	458	86464
1991	17261	17806	39	3619	376	13767	155	53025
1992	10596	15732	130	1497	119	3433	1502	33009
1993	9578	15577	241	3402	368	424	232	29821
1994	16180	57575	254	2958	216	4430	200	81814
1995	16022	13707	230	466	437	3786	55	34704
1996	14602	20837	27	153	161	5449	205	41433
1997	6516	5814	65	327	222	491	19	13455
1998	21160	21146	171	789	396	3110	94	46867
1999	5867	6138	365	264	171	615	20	13440
2000	9158	11932	508	329	348	1583	104	23962
2001	15464	9334	2339	867	417	1156	6	29584
2002	12077	5504	1914	778	440	1124	2	21840
2003	16244	15465	1090	956	929	1287	14	35985
2004	20064	11871	1183	650	1440	868	37	36113
2005	14175	13214	2874	668	1601	808	45	33385
2006	10983	7220	2829	428	920	504	28	22912
2007	15493	9669	3542	355	705	1748	14	31527
2008	11220	6268	3258	90	591	1915	31	23373
2009	15734	6991	1492	179	591	600	24	25610
2010	14084	3637	2544	268	577	185	7	21302

Table 10. Estimates of discards by species from the sink gill net fishery from 1968-2010.

				sink gill net				
Year	winter	little	barndoor	thorny	smooth	clearnose	rosette	Total
1968	0	1	2	42	2	0	0	46
1969	1	0	5	30	2	0	0	38
1970	1	0	0	26	2	0	0	29
1971	0	1	0	25	4	0	0	29
1972	4	1	0	36	4	0	0	45
1973	1	0	0	40	5	0	0	46
1974	1	1	0	67	14	0	0	82
1975	2	0	0	80	4	0	0	87
1976	2	2	1	113	18	0	0	135
1977	6	0	0	190	20	0	0	216
1978	4	1	0	205	45	0	0	255
1979	50	4	0	144	26	0	0	223
1980	55	12	0	184	33	0	0	285
1981	36	12	0	270	33	0	0	350
1982	40	17	0	112	6	0	0	175
1983	43	4	0	122	16	0	0	185
1984	65	11	0	136	5	0	0	217
1985	35	10	0	145	6	0	0	196
1986	60	8	0	174	14	0	0	257
1987	49	6	0	160	9	0	0	225
1988	45	44	0	141	21	0	0	252
1989	65	7	0	62	5	0	0	140
1990	48	33	0	300	40	0	0	421
1991	46	9	1	140	16	0	0	212
1992	66	147	18	138	8	0	0	376
1993	96	132	1	81	11	0	0	321
1994	89	221	1	136	25	18	2	492
1995	435	286	8	25	16	23	0	793
1996	324	188	2	8	3	23	1	550
1997	189	263	1	4	1	25	1	484
1998	163	261	1	4	6	32	2	469
1999	282	514	3	5	3	40	1	847
2000	651	247	12	29	16	19	0	973
2001	347	150	39	13	5	52	1	608
2002	2426	101	204	22	5	96	0	2856
2003	548	225	89	18	20	64	0	965
2004	501	248	134	15	25	25	0	948
2005	803	331	297	23	52	89	1	1596
2006	663	104	392	14	13	34	0	1222
2007	1184	315	172	10	20	108	3	1812
2008	650	295	742	3	18	320	0	2028
2009	1407	286	188	8	23	75	0	1988
2010	1471	122	764	6	15	23	0	2402

Table 11. Estimates of discards by species from the scallop dredge fishery from 1968-2010.

				scallop dredge				
Year	winter	little	barndoor	thorny	smooth	clearnose	rosette	Total
1968	4033	2592	88	711	67	402	37	7930
1969	1893	1886	52	684	33	415	3	4966
1970	1740	972	10	863	44	327	12	3969
1971	994	1229	55	1304	145	327	4	4059
1972	1094	1285	37	1410	159	184	7	4175
1973	1162	962	1	1493	188	64	2	3872
1974	983	1298	3	953	177	674	40	4129
1975	814	3209	5	1915	82	400	15	6439
1976	2373	4695	22	1390	151	1745	545	10921
1977	6070	5076	1	1935	128	1772	225	15206
1978	7750	5505	6	1820	173	4468	304	20025
1979	8742	6499	7	2260	215	2313	111	20148
1980	7894	5193	1	3929	691	1069	318	19096
1981	11129	4131	1	3432	327	777	53	19850
1982	9669	6476	2	1431	84	188	20	17869
1983	7781	6794	0	1621	202	2301	26	18725
1984	7927	5517	2	1295	46	1757	487	17031
1985	6489	6130	1	1222	47	780	11	14680
1986	9984	2912	10	886	90	3661	22	17565
1987	12266	10899	7	849	54	3517	851	28442
1988	15736	10907	6	1305	194	621	1872	30640
1989	19790	12712	7	1419	162	1725	170	35986
1990	25519	6877	44	2129	180	3149	253	38151
1991	17490	9545	15	2434	207	4573	94	34358
1992	18091	8846	90	1794	195	2849	783	32646
1993	6497	12525	109	1762	203	702	239	22037
1994	2229	5939	48	1419	217	1161	142	11155
1995	9186	18712	59	109	113	241	159	28578
1996	5587	13517	90	173	166	90	205	19828
1997	4018	12444	305	155	217	212	46	17396
1998	3444	10989	122	219	227	145	116	15263
1999	2679	11971	117	132	75	96	78	15149
2000	1901	7637	74	94	68	71	73	9918
2001	1108	5600	32	23	50	72	127	7011
2002	1889	11300	160	38	87	236	75	13785
2003	2051	13436	92	127	213	43	21	15982
2004	3053	5536	79	32	96	496	17	9310
2005	3174	6686	397	59	152	168	56	10691
2006	3717	6079	395	92	151	208	22	10663
2007	3711	8579	324	70	122	185	29	13019
2008	2398	6613	290	31	250	383	40	10006
2009	2485	4228	335	18	48	153	23	7290
2010	4325	8446	303	22	52	196	21	13366

Figure 5. Comparison of discard rates on At-Sea-Monitoring and Sea Sampler Observer Program trips. X-axis represents SBRM fleets, numbered 1 to 52 (see 2010 SBRM report for documentation). Y-axis represents a ratio in relative discard rates between the two programs (ASM/SSOP).

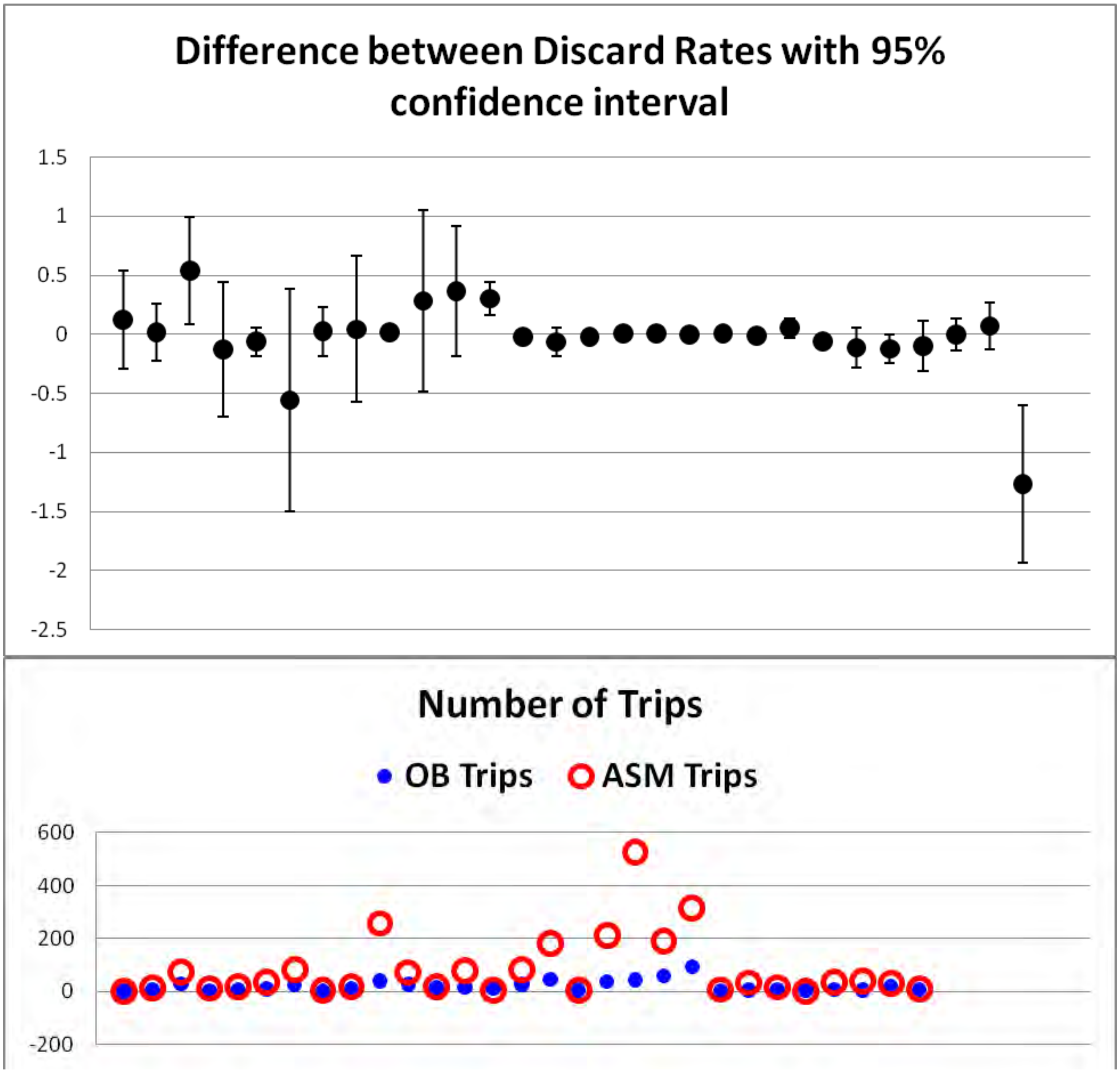


Figure 6. Comparison of discard rates on At-Sea-Monitoring and Sea Sampler Observer Program trips. X-axis represents SBRM fleets, numbered 1 to 52 (see 2010 SBRM report for documentation). Y-axis represents a ratio of groundfish to non-groundfish discard rates between the two programs (ASM/SSOP).

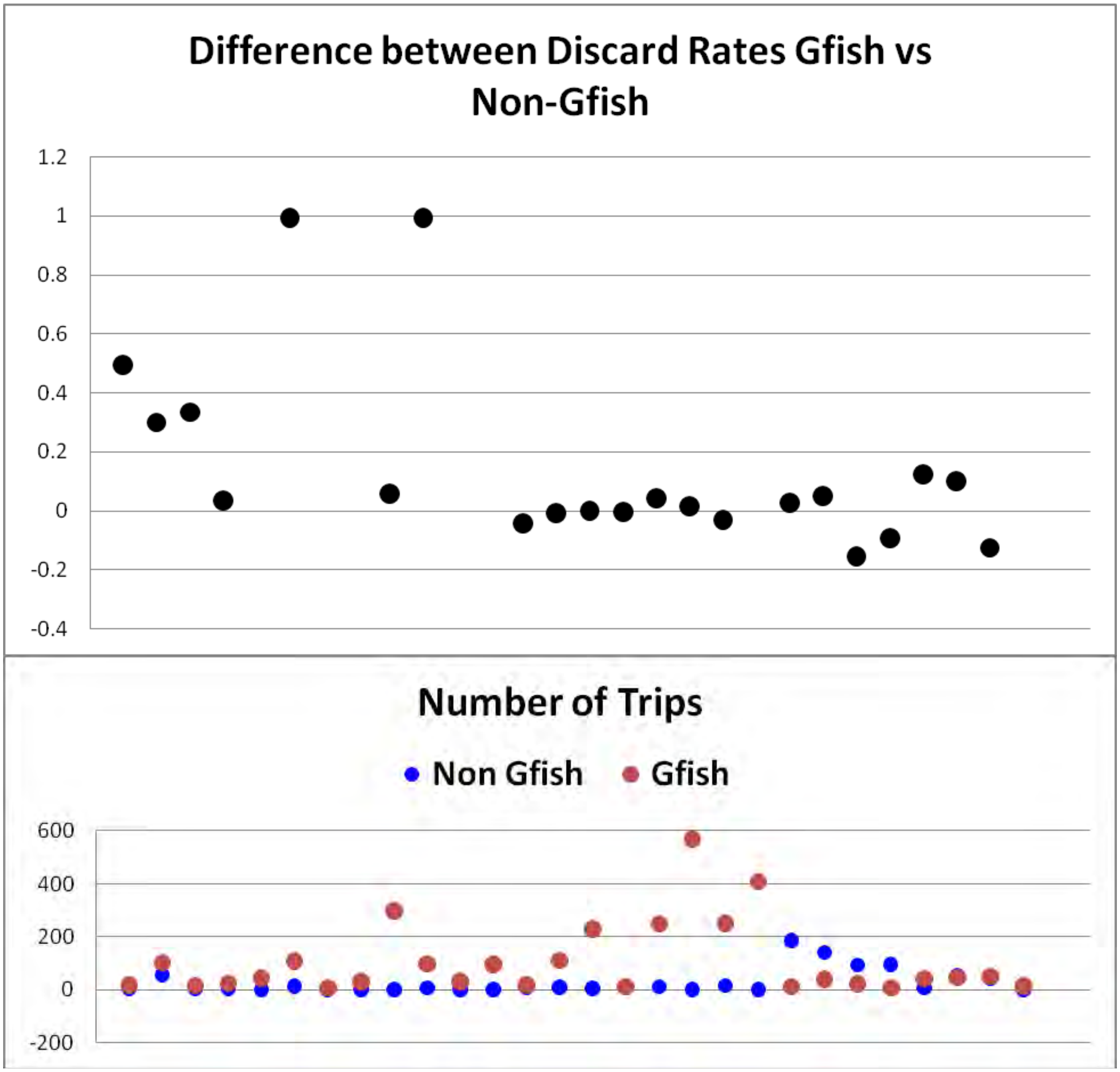


Table 12. Comparison of different trawl types.

gear type	discard to kept ratio	mt in dealer	Number of trips observed	Number of trips in dealer
otter	0.277	83597	2124	20439
ruhle	0.291	131	31	39
haddock separator	0.427	2323	122	144

Applying a 50% discard mortality rate, the total dead discards were estimated at 18,744 mt. The discard rate for 2010 was therefore 56.6 percent of the total catch and for the 2008-2010 period was 51.0 percent (an decrease from the 52% discard rate in the 2010 specifications). This three year average discard rate is assumed to apply in the specifications according to approved Amendment 3 procedures.

Including transfers at sea in landings, the 2010 discard rate is estimated to be 44.5%, or 47.9% averaged over 2008-2010. Revising the assumed discard mortality rate for little (M=0.20) and winter (M=0.12) skates captured by trawl gear (Section 7.0), the estimated 2010 discard rate is 30.3%, or 36.3% averaged over 2008-2010.

Changes in discard estimation and discard mortality affected the entire catch history. These revisions also affect the estimation of MSY, because they change the catch/biomass medians derived from historic catches before 2008. Total catch including landings and dead discards assuming a 50% mortality rate are graphed against annual MSY estimates in Figure 7. Total catch was near the ABC level in 1994, 1996, 1998, and 2007, but generally has been around 20,000 to 40,000 mt annually since 1990 and was near the ACT level, if current ACL policies had been in place. Total catch increased since 2006 to near time series high in 2008 and 2009, before declining in 2010 under ACL management. Total landings have been below the recalculated TAL since 2009[1]. MSY (here defined as the catch resulting from application of the catch/biomass medians to the target skate biomass levels) is estimated to be 63,192 mt.

If lower and variable discard mortality is assumed for little and winter skates captured by vessels using trawls, the catch history is plotted in Figure 8. Total skate catch varied from 20,000 to 30,000 mt since 1989 and was above the ABC level (associated with the catch/biomass median) in 1996 and 2007. Due to the lower discard mortality assumption, landings are a greater fraction of the catch and increased above the TAL level since 2006, before dropping below the revised TAL estimate in 2010. MSY (here defined as the catch resulting from application of the catch/biomass medians to the target skate biomass levels) is estimated to be 46,192 mt.

[1] The actual TAL was lower in 2010 because it was based on 2006-2009 survey data and 2007-2009 discard estimates.

Figure 7. Total annual skate landings and catch plotted against annual ABC estimates using a three year moving average for skate biomass using FSV Bigelow surveyed strata, with updated discard mortality estimates, reported skate transfers at sea, and constant discard mortality assumed to be 50% based on published literature. The ACL specifications in 2010 use data from survey biomass for the 2008 FSV Albatross survey and 2009-2010 calibrated FSV Bigelow surveys.

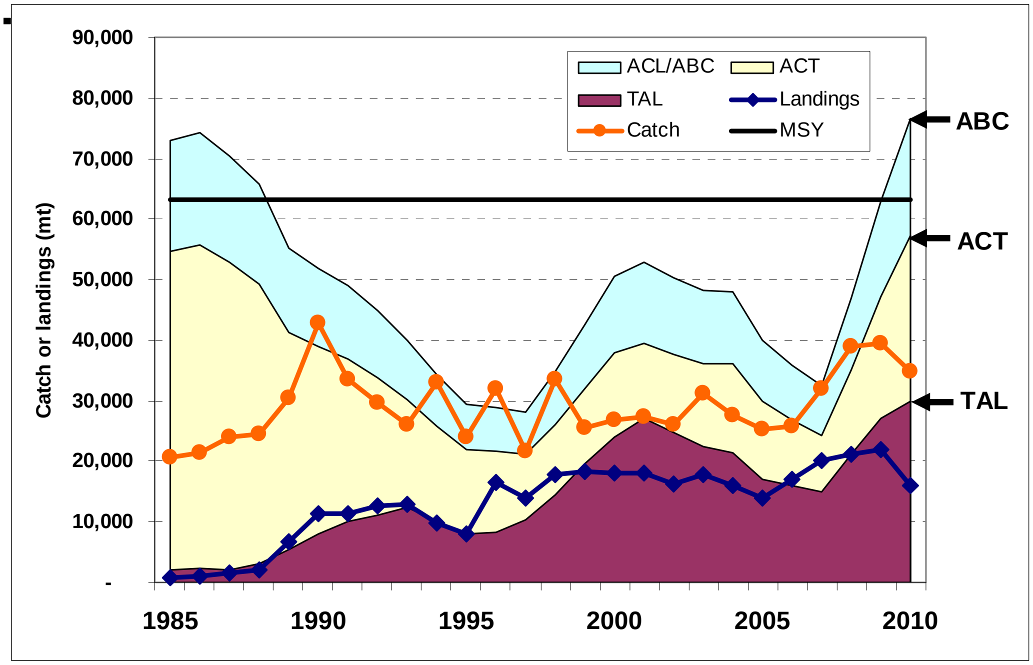
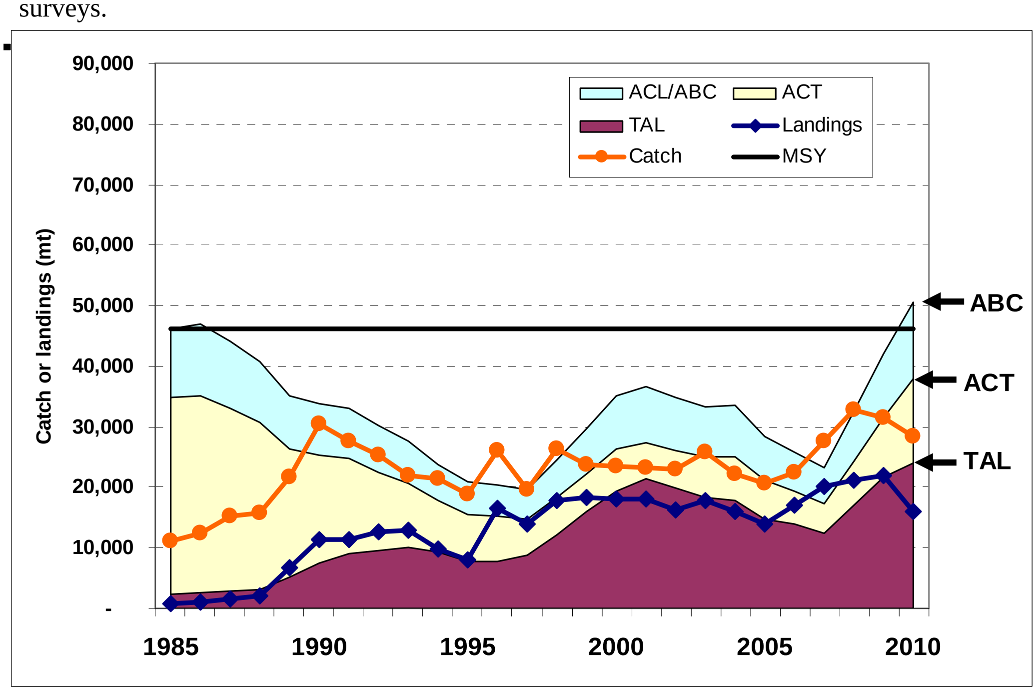


Figure 8. Total annual skate landings and catch plotted against annual ABC estimates using a three year moving average for skate biomass using FSV Bigelow surveyed strata, with updated discard mortality estimates, reported skate transfers at sea, and variable discard mortality for little and winter skates based on recent research on commercial vessels fishing in the Gulf of Maine. The ACL specifications in 2010 use data from survey biomass for the 2008 FSV Albatross survey and 2009-2010 calibrated FSV Bigelow surveys.



6.0 Accountability measures

Since neither the skate wing nor skate bait landings by vessels holding federal permits exceeded 105% of the wing or bait TALs implemented in Amendment 3 for 2010, they did not trigger TAL-related AMs. Had either TAL been exceeded by more than 5%, the inseason trigger point (specified percent of the TAL) where possession limits are reduced to the incidental level, would have been automatically lowered in proportion to the overage. Amendment 3 set this fraction at 80% of the wing TAL and 90% of the bait TAL. Skate Framework Adjustment 1 increased the skate wing AM trigger to 85% of the TAL.

Even though transfers at sea for bait were not originally included in the 2010 ACL specifications, they accounted for 4% of the 41,080 mt ACL and were included in the estimated total removals, absorbed in the 25% buffer between the ACL and the ACT for management uncertainty. Estimated dead discards assuming a 50% mortality rate in 2010 accounted for 46% of the ACL. Taken together, total removals (federal and state landings, transfers at sea, and dead discards) totaled 77.2 million pounds (35,477 mt) or 85% of the 2010 ACL, exceeding the ACT but not exceeding the ACL. Since total catch did not exceed the ACL in 2010, no automatic AMs were triggered.

7.0 Discard mortality

Data on immediate- and delayed (i.e. post-release) mortality rates of discarded skates and rays is extremely limited. Only five published studies have estimated discard mortality rates in these species (Table 13), and only one examined a skate from the Northeast Skate Complex (winter skate, Benoit 2006). Based largely upon the results of this study, which estimated acute discard mortality rates of winter skates caught in Canadian bottom trawl surveys, the SSC in 2009 decided to use a 50% discard mortality rate assumption for all skates and gears for the purposes of setting the Skate ABC.

Since skate discards are high across many fisheries, the estimates of total skate catch are sensitive to the discard mortality rate assumption, and have direct implications for allowable landings in the skate fisheries. Therefore, the PDT reviewed the best available scientific information on skate discard mortality rates to determine if the 50% assumption is still appropriate. The review included summarizing old and new published data (Table 14), as well as receiving a report on the preliminary findings of a focused skate discard mortality study being carried out in the Gulf of Maine by Drs. John Mandelman (New England Aquarium) and James Sulikowski (University of New England). The results are summarized below.

7.1 Literature Review

Table 13 summarizes the results of the five studies on skate/ray discard mortality rates. The study locations, fisheries, species, and gears varied across these studies, however most used some type of trawl gear. Only one study (Benoit 2010) estimated the skate discard mortality rate in scallop dredge gear (10% for winter skate). Discard mortality rates for skates have not been estimated in any other gear types (e.g., gillnet, hook gear). Due to the differences in study objectives, methods, and sample sizes across these investigations, it is difficult to directly compare these results, but they may inform the range of reasonable mortality rate assumptions for the Northeast Skate Complex.

Overall, discard mortality rates of skates and rays in trawl gears ranged from 10-100%. Mortality rates varied greatly between species. However, across this broad range of species, the mean discard mortality rate was approximately 50% (±1 standard deviation = 24%). While there are some significant assumptions associated with applying this information to the Northeast Skate Complex, it appears that the current scientific literature supports the use of an assumed 50% discard mortality rate for skates in trawl gear. However, more research is clearly needed on this subject area.

Despite the Benoit (2010) estimate of winter skate discard mortality rates in scallop dredge gear (10%), the PDT decided that this estimate is not applicable to the Northeast Skate Complex. The Benoit study was conducted in the Gulf of St. Lawrence using at-sea observer data, and the dredge gear (small bucket scallop dredges) are not considered comparable to the New Bedford style dredges used in the New England scallop fishery. Given the magnitude of skate discards by scallop dredge vessels (Table 6), research on discard mortality rates in this gear should be a high priority.

Table 13. Summary of published skate and ray discard mortality rate studies.

Source	Location	Gear Type	Skate/Ray Species	Discard Mortality Rate (%Dead)
Stobutzki et al. (2002)	N. Australia	Prawn Trawl	56 elasmo species	**56% (range = 10-82%)**
			All rays	**61%**
			Dasyatidae	**59%**
			Gymnuridae	**41%**
			Rhynchobatidae	**10%**
Laptikhovsky (2004)	Falkland Islands	Squid Trawl	*Bathyraja albomaculata*	**28.6%**
			B. brachiurops	**45.4%**
			B. griseocauda	**100%**
			B. macloviana	**100%**
			B. magellanica	**40%**
			Bathyraja sp.	**25%**
			Psammobatis sp.	**40%**
Benoit (2006)	Gulf of St. Lawrence	Bottom Trawl	*Leucoraja ocellata*	**50%**
Enever et al. (2009)	Bristol Channel, UK	Bottom Trawl	4 skate species	**mean = 45%**
			Leucoraja naevus	**67%**
			Raja microocellata	**49%**
			Raja brachyura	**45%**
			Raja clavata	**41%**
Benoit (2010)	Gulf of St. Lawrence	Scallop Dredge	*Leucoraja ocellata*	**10%**
			MEAN TRAWL	**50%**

7.2 Skate Discard Mortality Research in the Gulf of Maine

Drs. John Mandelman and James Sulikowski received NOAA funding in 2009 (Saltonstall-Kennedy Grant Program) to investigate the immediate and short-term discard mortality rates of skates in the Gulf of Maine. Their study is investigating mortality rates of winter, little, thorny, and smooth skates captured by otter trawl gear. The research is ongoing, but preliminary data were presented to the PDT on discard mortality rates of little and winter skates, which dominate the skate catch in the region.

Since a variety of factors contribute to discard mortality rates (e.g., tow duration, temperature differentials, fish size and sex, tow weight, deck time and handling, etc.), the researchers are attempting to account for each of these variables. Trials were done with tow durations of 20-30 minutes (controls), 2 hours, and 3-4 hours, accounting for the range typical of industry practices in this region. The distribution of the estimated catch biomass load per tow in the study, a factor previously shown to positively correlate with the mortality of discarded finfish bycatch, was also reported as broad, and included heavily packed tows. Skates were sampled from the catch and given a standardized condition index of 1-3 based on the extent of visible injuries and general condition (i.e. energy levels). They were then placed in specially-designed cylindrical mesh cages (with sea lice resistant bottoms), and returned to the water for a period of 72 hours. The biomass of skates in each cage was kept relatively constant between trials. The cages were then retrieved and sampled for the numbers of dead and alive skates.

So far, over 650 individual skates have been sampled for immediate and delayed mortality, including 243 little skates (18-60 cm TL) and 203 winter skates (23-95 cm TL) on 37 tows (the number of specimens assessed for immediately mortality only exceeds 2000). Initial results indicate that immediate at-vessel mortality of trawl-caught skates (all species) is near zero. Excluding skates from the shorter control tows (to more closely approximate commercial tow durations), pooled mortality rates after the 72-hour cage trials were 20% for little skate and 12% for winter skate (see table below). Significant predictors of mortality included condition index (more injuries resulted in higher mortality) and sex (males had higher mortality than females). Other variables were not significant, however, the researchers acknowledge that sample size is still relatively low at this time.

Table 14. Preliminary estimates of Gulf of Maine little and winter skate delayed (72-h) discard mortality rates in trawl gear.

Tow Duration	**2h**			**3-4 hr**			**Total**		**Pooled**
	N tows	Dead	Alive	*N tows*	Dead	Alive	Dead	Alive	**%Mortality**
Little	6	18	61	4	17	79	35	140	**20%**
Winter	11	3	47	11	21	124	24	171	**12%**

This project is anticipated to be completed in 2011. Laboratory-based experiments on the physiological effects of aerial exposure stress on little and thorny skates are also ongoing. The researchers expect to complete analysis of final study results in 2012, including mortality rate estimates for thorny and smooth skates, and a complete analysis of mortality predictor variables.

7.3 PDT Recommendations

Despite the results of the skate discard mortality project being preliminary, the PDT felt that they represented the best available scientific information for the Northeast Skate Complex. While the literature on other species and fisheries generally appears to support a 50% discard mortality rate assumption, data collected on regional skate species using regional fishing practices is more directly applicable. Drs. Mandelman and Sulikowski felt strongly that species specific differences in discard mortality were important, so the preliminary results for little and winter skates were not directly applicable to other skate species, such as thorny and smooth skates which were also caught in the study. At this time, samples were at this time insufficient to estimate discard mortality for these species. More discard mortality trials are currently underway and final results may provide discard mortality estimates for these species. In the meantime, the PDT decided that the existing working assumption of 50% discard mortality for all species except for little and winter skates captured by commercial length trawl tows was appropriate.

The PDT is therefore recommending that for little and winter skates discarded by trawl gear, the assumed mortality rates should be changed to 20% and 12%, respectively. This assumption was applied (Section 5.0) by disaggregating the discard estimates for each gear type by species using methods approved by the Northeast Data Poor Stocks Working Group (NEFSC 2009). The applied discard mortality rate varies by year (Table 15) due to the differences in the proportions of little and winter skate discarded by gear type.

This new discard mortality assumption changes the perception of discard mortality by species Figure 9 shows the estimated trends in dead discards assuming a 50% discard mortality rate for all species and gears, the substantial majority from discards of the more abundant little and winter skates. Figure 10 shows the estimated trends in dead discards assuming a variable mortality rate, with a 20% discard mortality rate applied to little skates and a 12% discard morality rate applied to winter skates when either was captured by trawls in the expanded discard estimates by gear. Dead discards of the more abundant little and winter skates still comprise a majority of total dead skate discards, but are much lower. The trends in total dead discards are similar to that assuming a 50% discard mortality rate, but thorny skate discards were a large portion of the total before 1987.

The new discard mortality assumptions and discard estimates of course also change the estimates of current and historic skate catch (Section 8.0) and its application for setting the Skate ABC and for estimating MSY (Section 9.0). The estimates of historic catch and ACLs, calculated by applying the three year moving average biomass to the respective catch/biomass medians is shown in Figure 9 and Figure 10, respectively. Both the total catch and the respective ACL threshold and target catches change as a result of making different assumptions about the discard mortality rate, but trends in catch with respect to ACL thresholds and targets are similar. Catches were near the ACT level for most of the time series, except for 2007 and 2008 when increasing landings and discards as well as declining skate biomass caused the total catch to reach or exceed the ACL level.

Table 15. Weighted average discard mortality rates by species, assuming a discard mortality rate of 0.12 for winter skate and 0.20 for little skate captured by trawls, otherwise 0.50.

Winter	Little	Barndoor	Thorny	Smooth	Clearnose	Rosette	Weighted average	Three year weighted average
0.170	0.221	0.500	0.500	0.500	0.500	0.500	0.275	
0.150	0.216	0.500	0.500	0.500	0.500	0.500	0.253	
0.156	0.211	0.500	0.500	0.500	0.500	0.500	0.271	0.266
0.152	0.220	0.500	0.500	0.500	0.500	0.500	0.301	0.272
0.150	0.224	0.500	0.500	0.500	0.500	0.500	0.285	0.285
0.152	0.216	0.500	0.500	0.500	0.500	0.500	0.287	0.291
0.147	0.224	0.500	0.500	0.500	0.500	0.500	0.282	0.285
0.153	0.253	0.500	0.500	0.500	0.500	0.500	0.300	0.289
0.187	0.266	0.500	0.500	0.500	0.500	0.500	0.316	0.299
0.214	0.276	0.500	0.500	0.500	0.500	0.500	0.314	0.310
0.207	0.281	0.500	0.500	0.500	0.500	0.500	0.304	0.310
0.215	0.269	0.500	0.500	0.500	0.500	0.500	0.293	0.303
0.193	0.276	0.500	0.500	0.500	0.500	0.500	0.286	0.294
0.208	0.263	0.500	0.500	0.500	0.500	0.500	0.282	0.287
0.197	0.254	0.500	0.500	0.500	0.500	0.500	0.254	0.273
0.179	0.268	0.500	0.500	0.500	0.500	0.500	0.257	0.264
0.186	0.251	0.500	0.500	0.500	0.500	0.500	0.255	0.255
0.184	0.275	0.500	0.500	0.500	0.500	0.500	0.262	0.258
0.203	0.262	0.500	0.500	0.500	0.500	0.500	0.281	0.265
0.236	0.307	0.500	0.500	0.500	0.500	0.500	0.306	0.284
0.251	0.310	0.500	0.500	0.500	0.500	0.500	0.301	0.296
0.288	0.298	0.500	0.500	0.500	0.500	0.500	0.313	0.307
0.278	0.249	0.500	0.500	0.500	0.500	0.500	0.302	0.305
0.318	0.307	0.500	0.500	0.500	0.500	0.500	0.367	0.324
0.368	0.315	0.500	0.500	0.500	0.500	0.500	0.373	0.340
0.277	0.335	0.500	0.500	0.500	0.500	0.500	0.342	0.363
0.171	0.229	0.500	0.500	0.500	0.500	0.500	0.250	0.312
0.265	0.374	0.500	0.500	0.500	0.500	0.500	0.342	0.301
0.232	0.319	0.500	0.500	0.500	0.500	0.500	0.310	0.294
0.272	0.406	0.500	0.500	0.500	0.500	0.500	0.366	0.334
0.178	0.304	0.500	0.500	0.500	0.500	0.500	0.271	0.306
0.250	0.401	0.500	0.500	0.500	0.500	0.500	0.363	0.317
0.206	0.319	0.500	0.500	0.500	0.500	0.500	0.298	0.300
0.156	0.314	0.500	0.500	0.500	0.500	0.500	0.268	0.306
0.224	0.402	0.500	0.500	0.500	0.500	0.500	0.339	0.303
0.176	0.341	0.500	0.500	0.500	0.500	0.500	0.297	0.301
0.180	0.298	0.500	0.500	0.500	0.500	0.500	0.260	0.296
0.207	0.304	0.500	0.500	0.500	0.500	0.500	0.297	0.285
0.233	0.339	0.500	0.500	0.500	0.500	0.500	0.320	0.290
0.214	0.344	0.500	0.500	0.500	0.500	0.500	0.312	0.309
0.205	0.358	0.500	0.500	0.500	0.500	0.500	0.328	0.319
0.201	0.319	0.500	0.500	0.500	0.500	0.500	0.272	0.305
0.236	0.411	0.500	0.500	0.500	0.500	0.500	0.330	0.310

Figure 9. Total dead discards assuming discard mortality is equal to 50% for all species and gears.

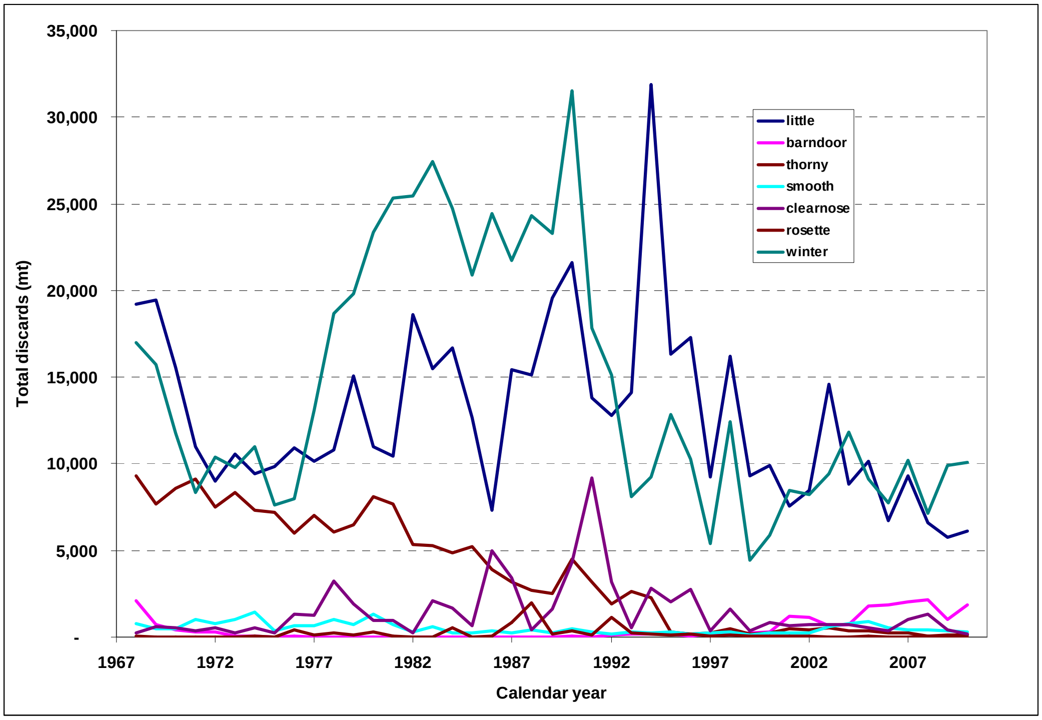
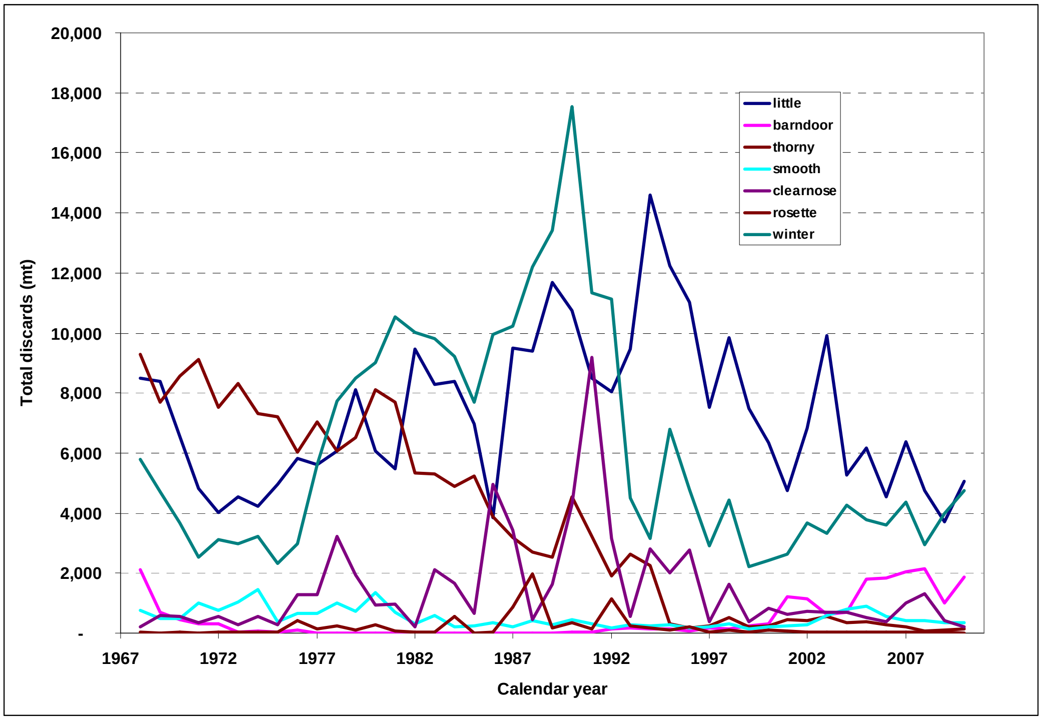


Figure 10. Total dead discards assuming discard mortality is 12% for winter skate and 20% for little skate captured by trawls, otherwise 50%.



8.0 Discard rate

The discard rate is assumed to apply to the 2012-2013 specification period based on the proportion of dead discards in the total skate catch (landings + dead discards) during the most recent three year period (2008-2010).

Trends in discard mortality are similar, whether a 50% or variable (see Section 7.0) discard mortality rate is assumed. Dead discards as a proportion of total catch declined from 1985 to 1999 (30% of total catch with a 50% discard mortality assumption and 22% of total catch with a variable rate discard mortality assumption for little and winter skates) (Figure 11 and Figure 12). Since 1999, using either dead discard mortality assumption, dead discards have increased as a proportion of total catch.

In 2010, the three year moving average discard rate increased to 47.9% of total catch assuming a 50% discard mortality rate and 36.3% of total catch assuming a variable discard mortality rate. Discards for 2010 included January through July before Amendment 3 implementation, July to August when a 5,000 lbs. skate wing possession limit existed, and September to December when the 500 lbs. incidental skate wing possession limit was in effect. Discard estimates for January to April 2011 will not be available until May 2012 due to reporting and data processing procedures.

Figure 11. Trend in calendar year skate discard rate with updated discard estimates and 50% discard mortality for all species and gears.

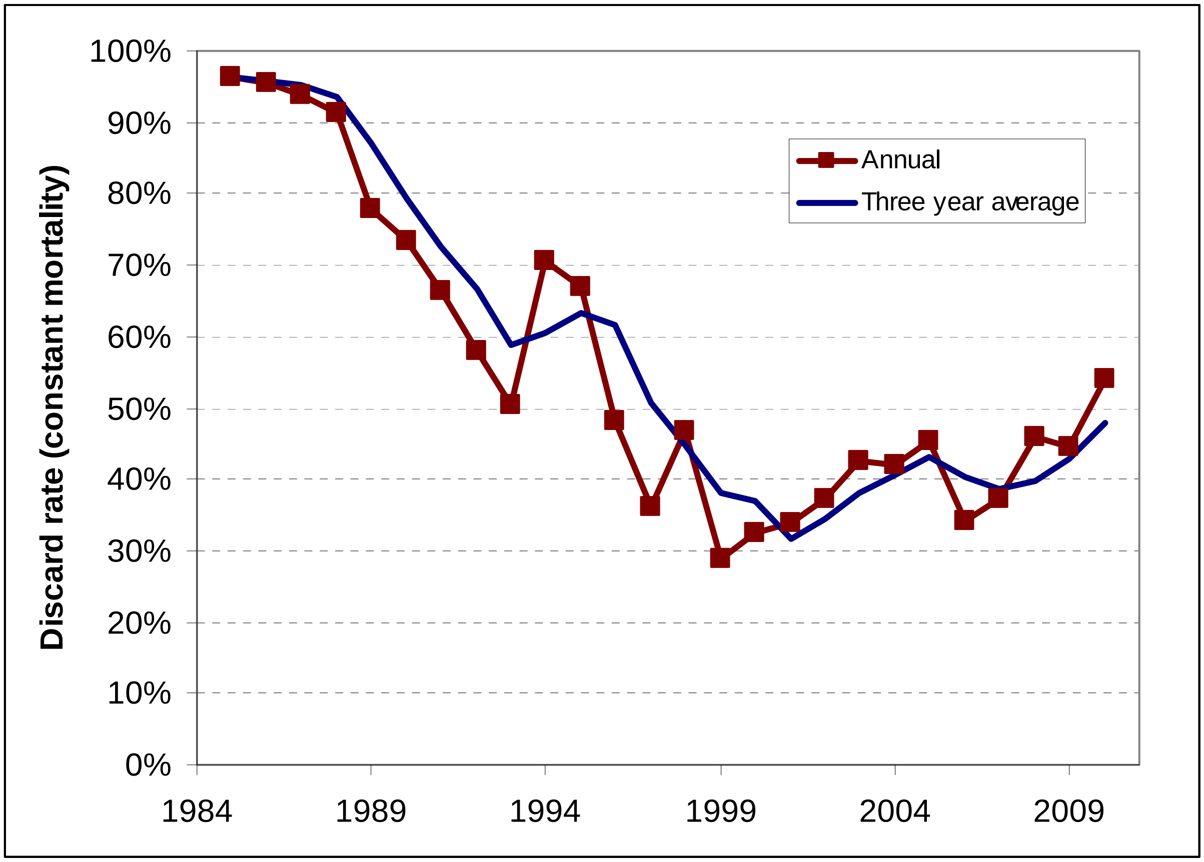
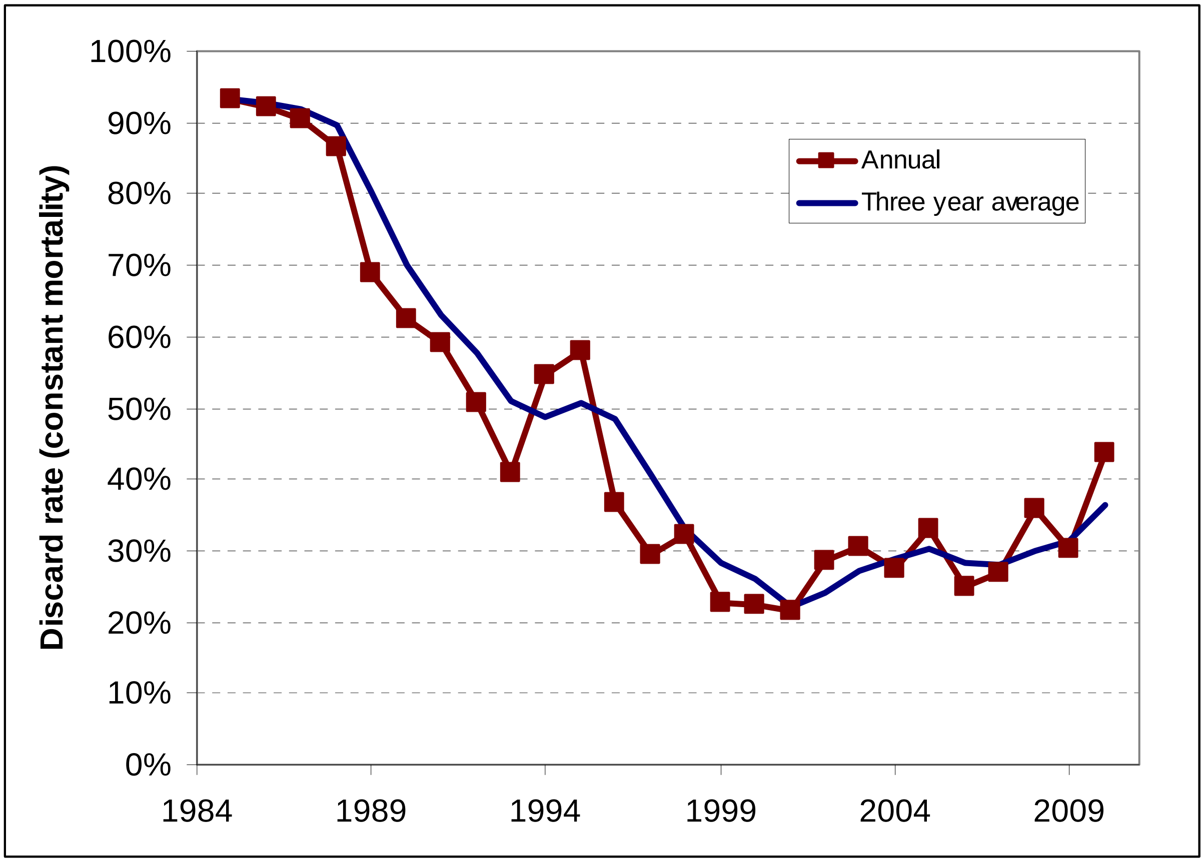


Figure 12. Trend in calendar year skate discard rate with updated discard estimates and discard mortality=0.20 for little skate and 0.12 for winter skate caught by vessels using trawls.



9.0 ACL specifications

The largest change in proposed 2012-2013 skate complex ACL specifications occurs from increases in survey biomass (analysis B in the table below) from 2006-2008 to 2008-2010 time periods, mostly from increases in little and winter skate biomass. The average three year mean biomass increases from 5.04 to 7.80 kg/tow for little skate and from 5.23 to 9.68 kg/tow for winter skates. This survey biomass increases the ABC from 41,080 mt to 69,215 mt. All other ACL specifications increase accordingly.

Changing the assumption about state landings from 3% to 12.6% in analysis C (see table below) has no effect on the ABC, ACT, or TAL, but reduces the amount allocated to Federally permitted vessels, from 23,979 mt to 21,752 mt. Nonetheless this amount is a substantial increase over the 13,856 TAL in current specifications (analysis A) and is a 13.8 percent increase over the landings that occurred in 2007, the peak year of landings before Amendment 3.

Including reported skate transfers at sea for bait increases that catch biomass median values, particularly for little skate which is the chief component of skate bait fishery landings. The PDT assumed that the species composition of skate transfers at sea were the same as those that the DPWS estimated for the skate bait fishery.

The effect on the ACL specification of including transfers at sea in the calculations is to raise the ABC estimate (because the catch/biomass median values rise) and reduce the discard rate (because more landings are included in the denominator). The additional landings data raised the ABC estimate at the catch/biomass medians nearly 2,000 mt to 70,905 mt (analysis D in the table below). At the same time, the estimated discard rate for 2008-2010 declined from 52% to 43%, raising the TAL to 30,390 mt.

In 2010, the estimated discards increased to 18,744 mt and when combined with lower skate landings, the discard rate declined to 48 percent when skate transfers at sea are taken into account. Also updated were the discard estimates including the landings reported as transfers at sea. Including the transfers at sea in landings and re-estimating discards and catch/biomass medians for the time series increased the ABC to 76,491 mt (analysis E in the table below).

At the same time, updating the analysis to include discards for 2008-2010 increases the discard rate to 47.9%. And when combined with the revised ABC, results in a 29,900 mt TAL based on all landings sources and updated discard estimates.

Finally, new research in the Gulf of Maine on commercial trawl vessels indicates that the discard mortality rate for little and winter skates is less than formerly assumed (see Section 7.0). Applying the new discard mortality rate to little and winter skate discards in the trawl fishery reduces the overall skate discard mortality rate to M=0.31. The applied discard mortality rate was allowed to vary by species, using these new research mortality estimates, but are reported here as a weighted average for simplicity. The average fishing mortality rate for little and winter skate varied by year due to the proportion of estimated discards in the trawl fishery, ranging from 0.216 to 0.411 for little skate and from 0.253 to 0.367 for winter skate.

The effect of this change on ACL specifications is two-fold. Lower catches in the time series reduces the catch/biomass median values for little (from 3.516 to 2.384 kt/kg) and winter skates (from 4.029 to 2.256 kt/kg). The lower catch/biomass median values reduce the ABC estimate to 50,435 mt, which in turn also reduces the other ACL specifications accordingly (see analysis F in the table below). On the other side of the allocation calculations, the lower discard mortality also reduces the assumed dead discard mortality rate, because there are fewer dead discards as a proportion of total 2008-2010 skate catch. And as a result of revising the catch/biomass time series with the proposed little and winter skate discard mortality estimates and applying the revised discard rate, the recommended 2012-2013 TAL would be 24,088 mt. For the skate wing fishery, this final recommendation would mean that the allowable landings would be 10% higher than the peak 2007 landings, instead of a decrease of 27.5% in the current specifications.

Table 16. Current and proposed 2012-2013 skate complex ACL specification estimates and input data. Incremental changes to input data are shown in analyses B-E. Analysis F represents the proposed final 2012-2013 specifications.

	(A)	(B)	(C)	(D)	(E)	(F)
	Current specifications	Bigelow strata	Revised state landings assumption (12.6%)	Additional skate transfers at sea	Updated discard estimates	Proposed discard mortality rate
	2006-2008 survey, 2007-2009 discards	2008-2010 survey, 2007-2009 discards	2008-2010 survey, 2007-2009 discards	2008-2010 survey, 2007-2009 discards	2008-2010 survey, 2008-2010 discards	2008-2010 survey, 2008-2010 discards
ACL specifications						
ABC (mt)	41,080	69,215	69,215	70,905	76,491	50,435
ACT (mt)	30,810	51,911	51,911	53,179	57,368	37,826
TAL (mt)	14,780	24,903	24,903	30,390	29,900	24,088
Assumed state landings	924	924	3,151	3,829	3,767	3,035
Federal TAL	13,856	23,979	21,752	26,561	26,133	21,053
Wing TAL	9,214	15,946	14,465	17,663	17,378	14,000
Percent change 2007	-27.5%	25.5%	13.8%	39.0%	36.8%	10.2%
Bait TAL	4,642	8,033	7,287	8,898	8,754	7,053
Season 1	1,430	2,474	2,244	2,741	2,696	2,172
Season 2	1,722	2,980	2,703	3,301	3,248	2,617
Season 3	1,490	2,579	2,339	2,856	2,810	2,264
C/B medians						
Barndoor	3.230	3.222	3.222	3.242	2.938	2.938
Clearnose	2.440	2.695	2.695	2.699	5.910	5.910
Little	2.390	2.898	2.898	3.087	3.516	2.384
Rosette	2.190	2.090	2.090	2.103	3.622	3.622
Smooth	1.690	1.669	1.669	1.701	2.388	2.388
Thorny	3.140	3.117	3.117	3.117	2.300	2.300
Winter	4.120	4.067	4.067	4.072	4.029	2.256
Survey biomass (mean kg/tow)						
Barndoor	1.020	1.113	1.113	1.114	1.114	1.114
Clearnose	1.037	0.936	0.936	0.933	0.933	0.933
Little	5.040	7.801	7.801	7.848	7.848	7.848
Rosette	0.053	0.041	0.041	0.040	0.040	0.040
Smooth	0.133	0.162	0.162	0.161	0.161	0.161
Thorny	0.420	0.244	0.244	0.245	0.245	0.245
Winter	5.230	9.682	9.682	9.684	9.684	9.684
Discard rate	52.0%	52.0%	52.0%	42.9%	47.9%	36.3%
Discard mortality	50.0%	50.0%	50.0%	50.0%	50.0%	31.0%

10.0 Stochastic estimates of precision

Until now, the PDT has provided a deterministic estimate of ABC derived from the catch/biomass median values and stratified mean biomass by species. In this update, the PDT estimated how precise the ABC and ACL specifications are estimated by incorporating estimated variance of these variables. Using this approach, it is possible to put confidence intervals on the ABC estimate or estimate a coefficient of variation (CV).

But although precision can be estimated, it is not possible to quantify risk because the skate OFLs are parameterized in terms of a population change (a decline in the three year moving average of survey biomass which exceeds a species-specific, pre-determined threshold) instead of an Fmsy mortality rate translated into a catch threshold (with estimated scientific uncertainty).

One component of the skate ABC estimate is the stratified mean survey biomass for each species. The variances on the stratified mean can be calculated using standard NMFS software (SURVAN) and for 2009 and 2010 incorporates the additional uncertainty associated with the FSV Bigelow calibration coefficients.

For purposes of estimating ABC uncertainty, the mean biomass values were input into the calculations with $\mu=\bar{x}$ and $\sigma^2=s^2$ for 2008, 2009 and 2010, assuming a log-normal distribution of each year's stratified mean biomass which were then averaged over the three year period. The figures below shows the mean and variances used in this calculation.

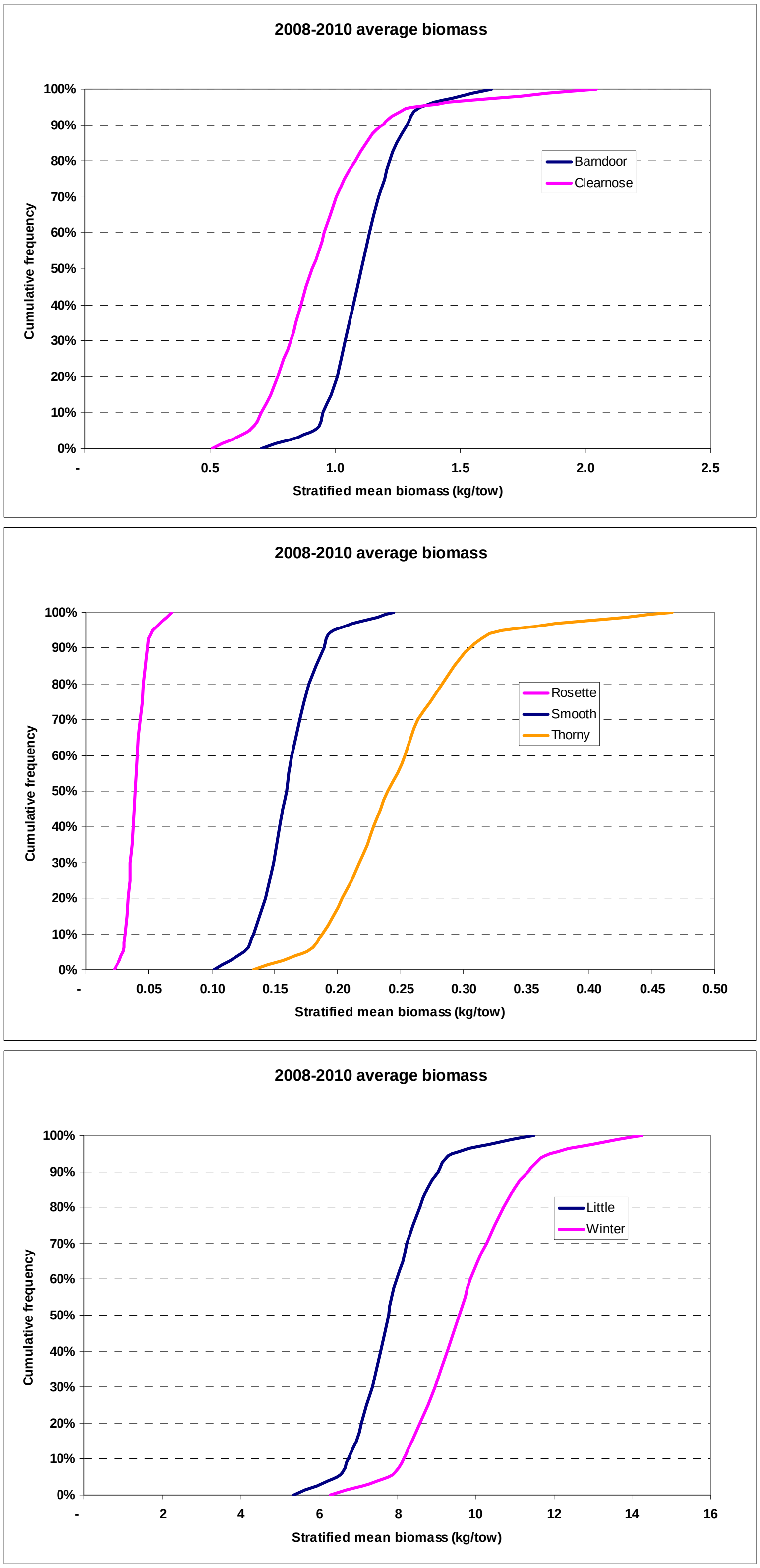
A bootstrap procedure (Efron and Tibshirani 1994) was applied to estimate the quantiles of the catch/biomass median value, derived from 1000 random draws without replacement from the three year catch/biomass time series for each skate species. Variance of the catch/biomass medians increases as fewer years are chosen in each iteration (probability of successful choice, *P*, ranging from 0 to 1). This empirical relationship varied among species, so the lowest value (highest variance on the C/B median) was chosen at the point where the mean value of the bootstrap results began to deviate from the time series median value due to non-normal characteristics as fewer years were drawn in each set of iterations (Figure 14). A value of 0.1 for P was chosen for smooth and thorny skate, 0.3 for winter skates, 0.5 for little and rosette, and 0.8 for clearnose skates. Statistics on the bootstrap distribution for the catch/biomass medians is given in the Figure 15. The mean catch/biomass median values were around 2-3 for all species except for rosette and clearnose skates, all catch/biomass values being fairly robust. Variation for clearnose and rosette are higher than for the other species. The higher variation for clearnose and rosette arises because of interannual variation in availability to the survey and due to errors in assigning catches to species using DPWS methods using survey data. These methods assume that availability to the survey and the commercial fishery follow the same trends, when if fact there is variation in this relationship, particularly for rosette and clearnose skates whose distribution is known to occur outside the survey strata boundaries.

The estimated distribution of ABC accounting for scientific uncertainty in catch and survey biomass is graphed in Figure 16. Uncertainty in the catch/biomass median and in the stratified mean biomass by species and year, including uncertainty in the calibration coefficient for 2009 and 2010 is estimated with 1000 iterations. The mean result is 49,405 mt with a standard deviation equal to 7,183 mt. The 80% confidence interval is 42,640 to 54,181 mt.

The estimated distribution of ABC accounting for scientific uncertainty in catch and survey biomass is graphed in Figure 17. Uncertainty in the catch/biomass median and survey biomass were estimated as above, but additional uncertainty in the discard mortality rate is estimated by allowing the mean annual mortality rate for little and winter skates to vary according to $\sigma^2=s^2$ for a 10 year moving average (to reduce the effect of trend in discard mortality on the variance)[2]. The mean result is 23,619 mt with a standard deviation equal to 3,446 mt. The 80% confidence interval is 20,823 to 25,996 mt

[2] Of course there is a more elegant method of dredge efficiency-trending the variance with time series analysis, but this effort suffered from the law of diminishing returns.

Figure 13. Cumulative distribution of 2008-2010 average skate biomass derived from variance on the calibrated (2008 uncalibrated) stratified mean biomass, input into stochastic estimate of ABC values.



Lacking a robust definition of overfishing (OFL) which is grounded in an estimate of F_{msy}, risk can be evaluated in terms of the observed population biomass response to previous levels of catch (defined here as a rate of catch/survey biomass, or kt/kg). In principle, this approach is theoretically consistent with the basis for skate overfishing definitions, a rate of decline that is beyond normal survey variation.

The graphs in Figure 18 show the empirical (1963-2007) responses in biomass at various levels of exploitation equivalent below confidence intervals around the catch biomass median. For barndoor skate, biomass increased much more frequently than not at any catch level around the catch/biomass median. Even with at catches below the 5% CI, biomass increased 14 of 18 years and the catch biomass median appears to be conservative at any confidence level accounting for scientific uncertainty. The same evaluation of risk holds true for little, rosette, thorny, and winter, although each have slightly different estimated risk levels. None of the catches below the various confidence levels for the above skates caused biomass to decline more often than not.

On the other hand, the catch/biomass median estimates at most confidence levels for clearnose skate were risk neutral. And for smooth skate, the catches below the 30 percent confidence level were conservative, but above the 30 percent confidence level were slightly risky.

Other sources of variation and scientific uncertainty arise from other assumptions and estimates that are only partially taken into account in this analysis. These input parameters include discard estimates, discard mortality, and species composition of the commercial catch (derived using the selectivity ogive method approved by the DPWS). To some extent, these sources of uncertainty are implicitly included in the catch/biomass bootstrap procedure, but could in some cases be more directly estimated and included in the ABC calculation procedure.

Finally, risk can only be assessed with respect to a reliable and robust MSY reference point estimate or more appropriately in terms of observed population response to previous catches under ACL management. The recent increase in skate biomass began long before the implementation of ACLs despite historically high skate catches, possibly as a result of transient phenomena, environmental forcing, or changes in abundances of prey and predators. One such relationship that has been postulated is the response to little skate to changes in Southern New England winter flounder abundance (or vice versa) since their diets overlap and they inhabit similar areas. This possibility will be examined in the 2011 Skate SAFE Report, although formal linkages would require targeted research. The PDT has also observed that little skate distribution has gradually expanded northward along the Gulf of Maine coastline, possibly contributing to the record high little skate biomass. Structural changes such as these cannot be adequately captured by the relatively simplistic (and reactionary) approach taken to set skate complex ABCs.

Figure 14. Mean and one standard deviation for bootstrap analysis of catch/biomass medians at various probabilities of being chosen (range 0.1 to 0.9). In each iteration, annual catch/biomass values are drawn without replacement.

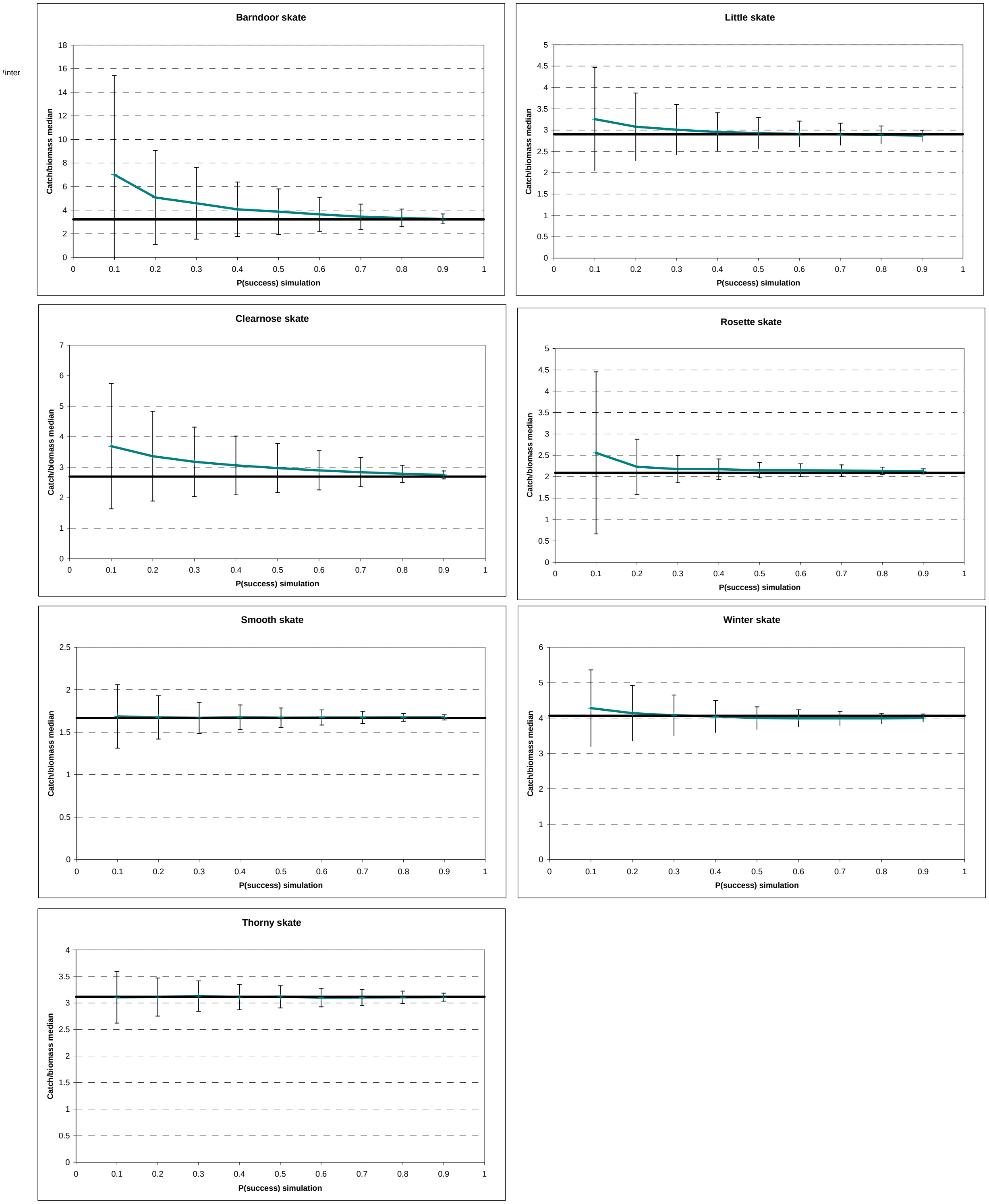


Figure 15. Mean and one standard deviation on bootstrap estimates of catch/biomass medians.

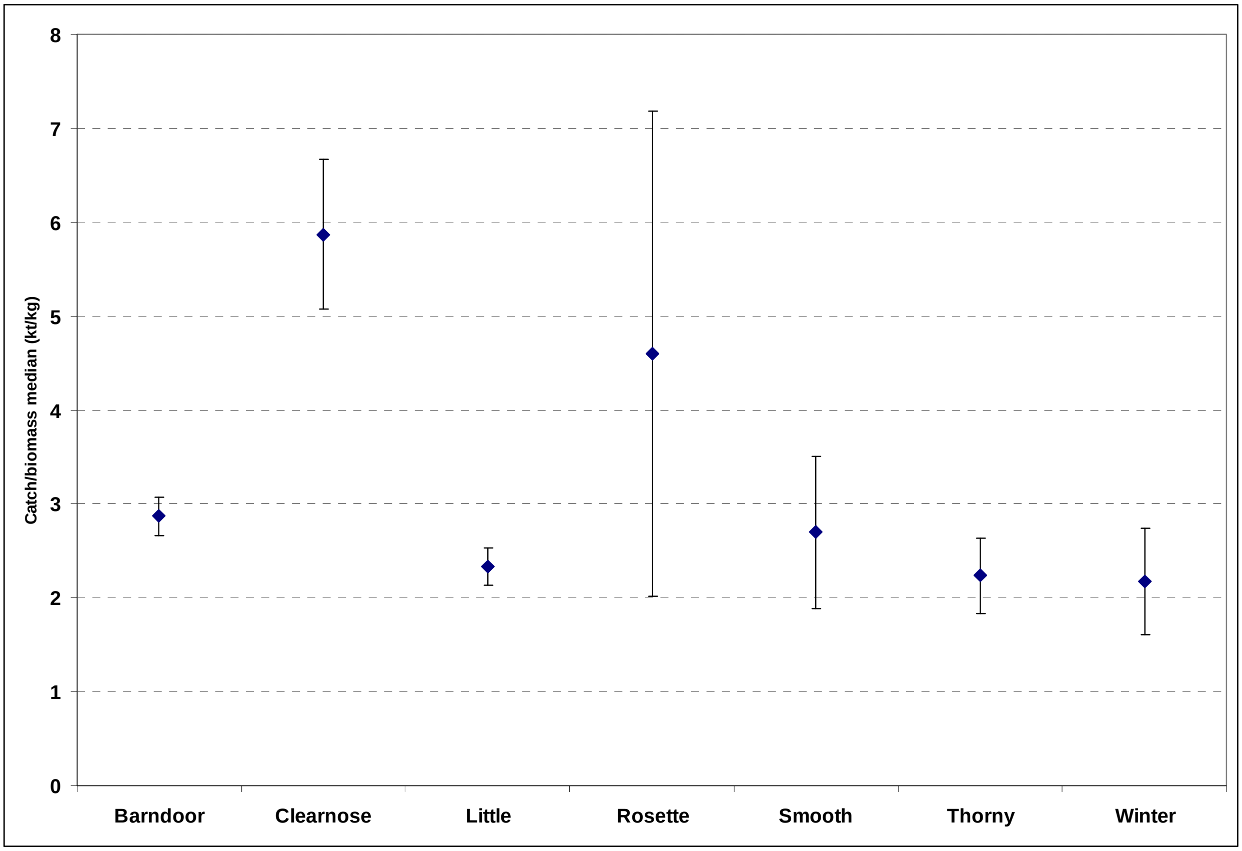


Figure 16. Frequency distribution of ABC accounting for catch and survey scientific uncertainty.

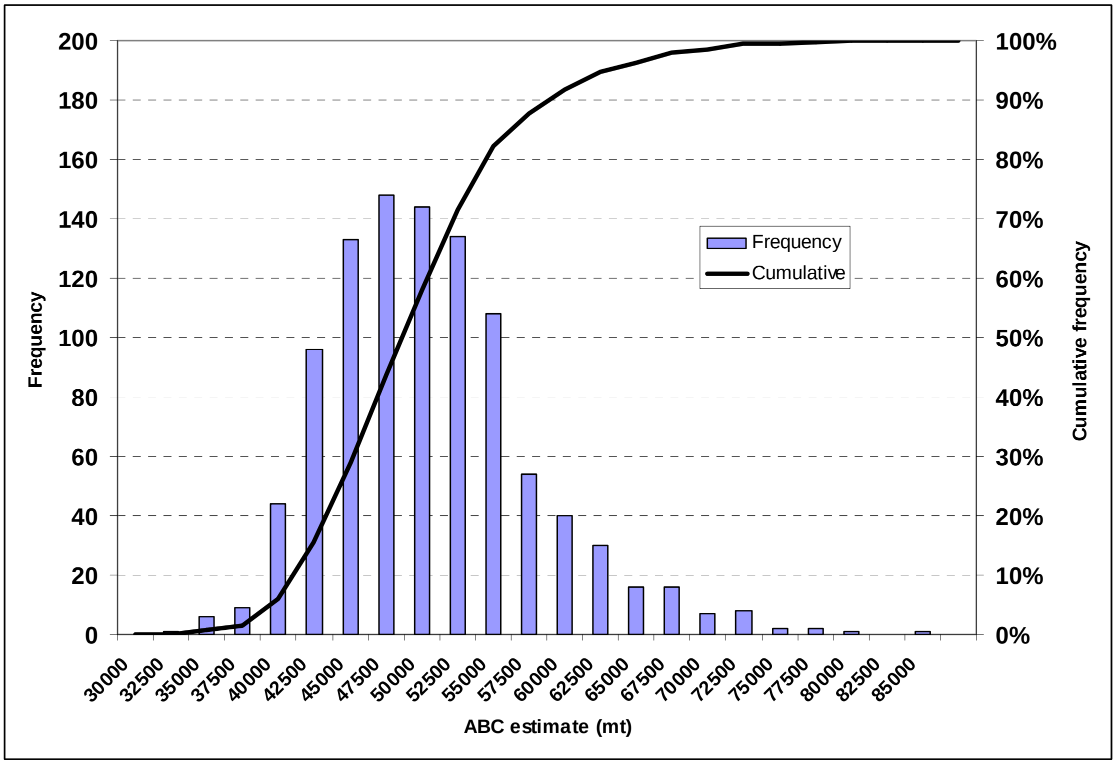


Figure 17. Frequency distribution of TAL accounting for catch discard mortality, and survey scientific uncertainty.

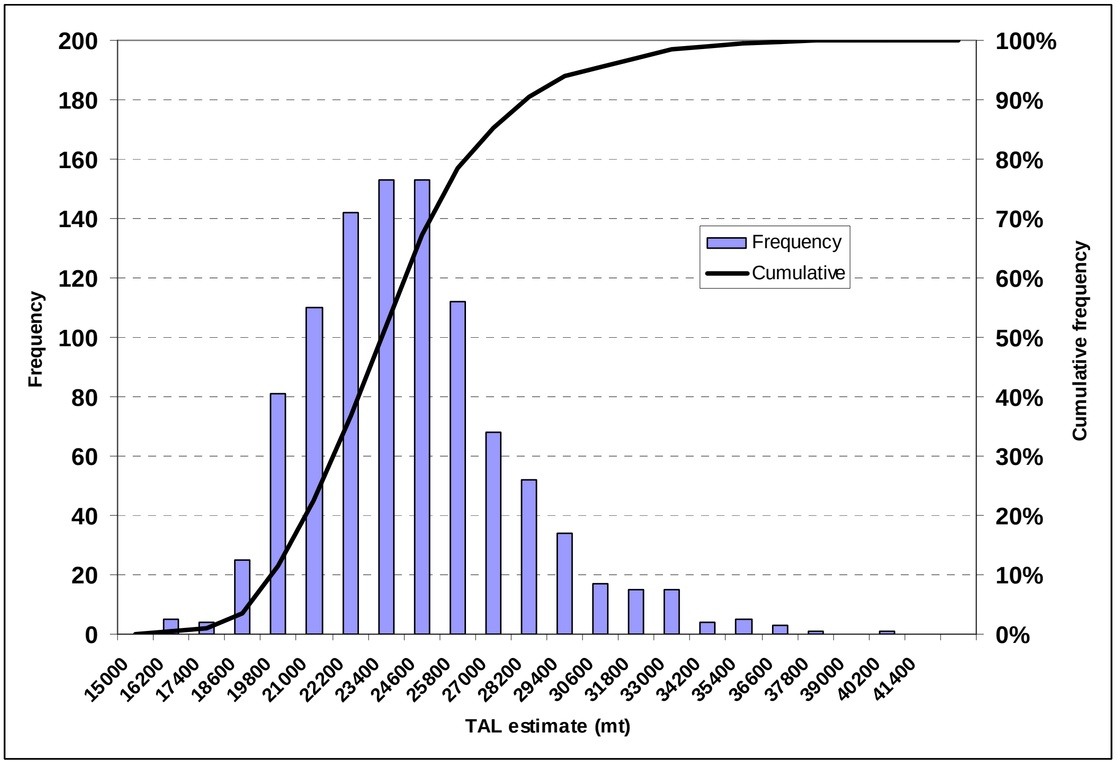
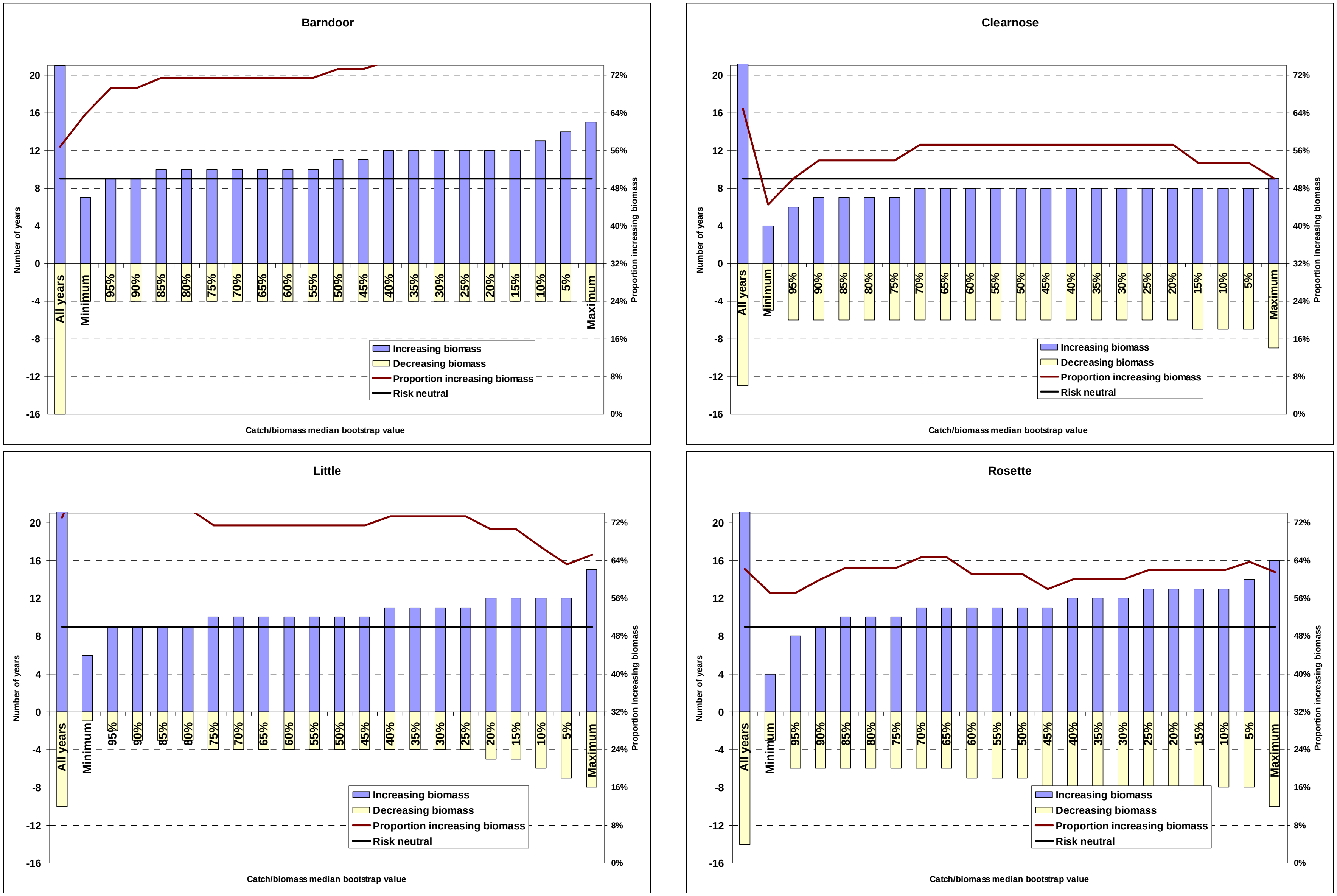
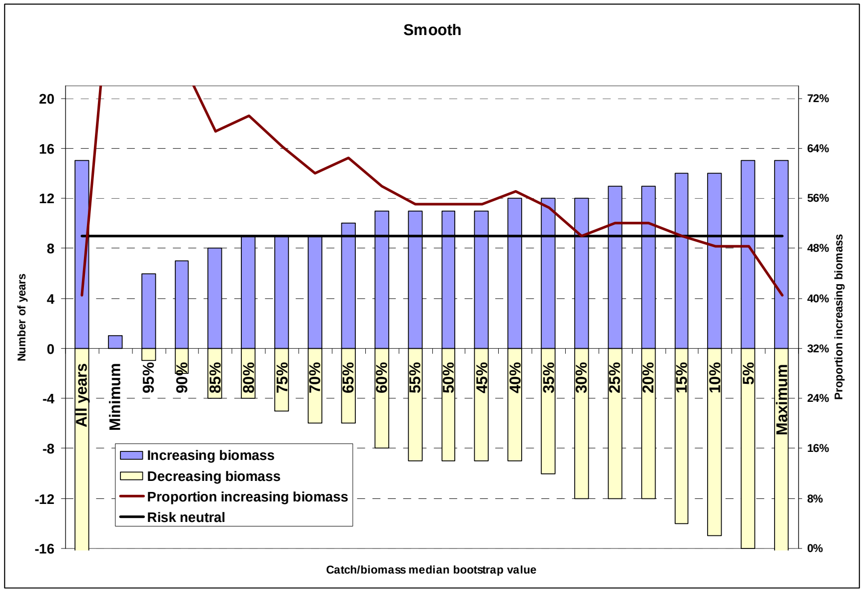
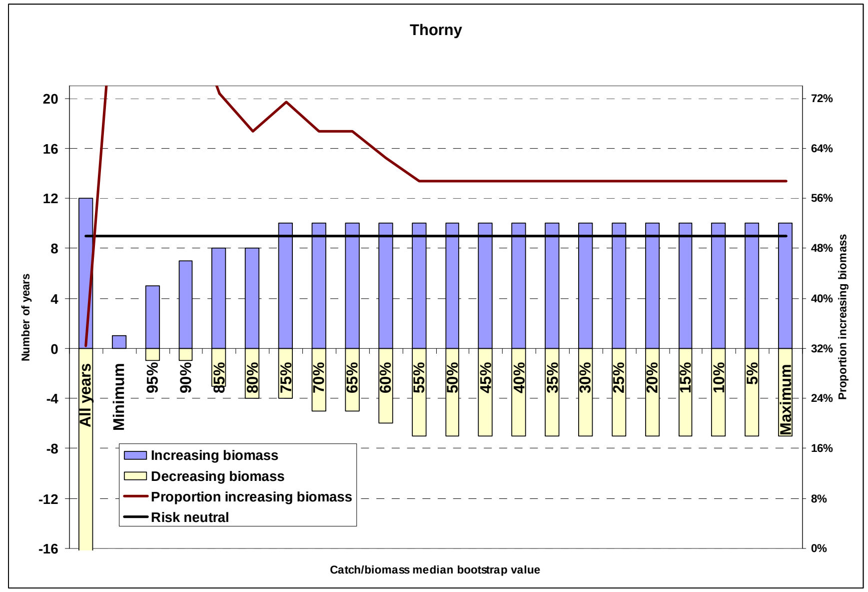
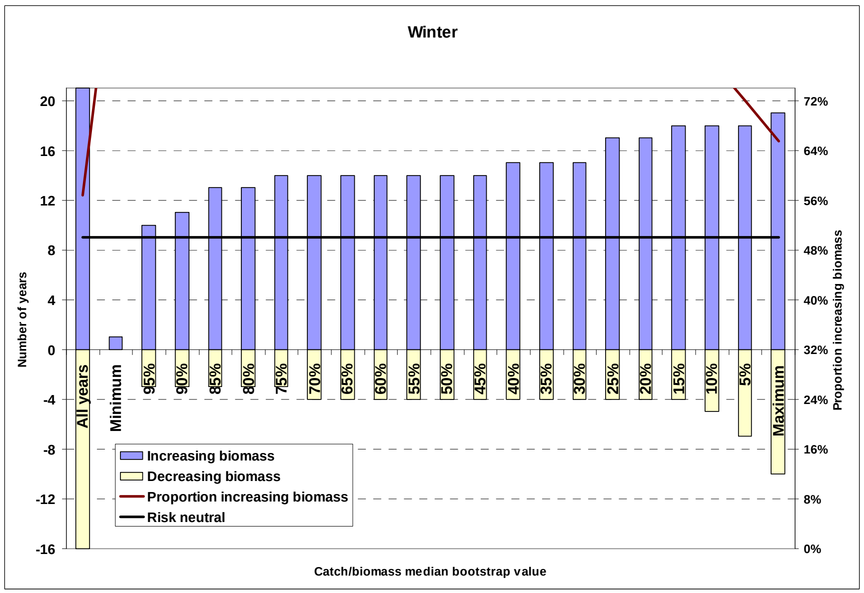


Figure 18. Empirical skate biomass response when catch levels were below confidence levels of the catch/biomass median values.




Smooth
Number of years
Proportion increasing biomass
20
16
12
8
4
0
-4
-8
-12
-16
72%
64%
56%
48%
40%
32%
24%
16%
8%
0%
All years
Minimum
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
Maximum
Increasing biomass
Decreasing biomass
Proportion increasing biomass
Risk neutral
Catch/biomass median bootstrap value


Thorny
Number of years
Proportion increasing biomass
20
16
12
8
4
0
-4
-8
-12
-16
72%
64%
56%
48%
40%
32%
24%
16%
8%
0%
All years
Minimum
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
Maximum
Increasing biomass
Decreasing biomass
Proportion increasing biomass
Risk neutral
Catch/biomass median bootstrap value


Winter
Number of years
Proportion increasing biomass
20
16
12
8
4
0
-4
-8
-12
-16
72%
64%
56%
48%
40%
32%
24%
16%
8%
0%
All years
Minimum
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
Maximum
Increasing biomass
Decreasing biomass
Proportion increasing biomass
Risk neutral
Catch/biomass median bootstrap value

11.0 Literature cited

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