

**2017 NE Skate Stock Status Update (NEFSC, Lead Analyst: K. Sosebee, 8/31/2018)**

Seven species of skates occur along the North Atlantic coast of the United States: winter skate (*Leucoraja ocellata*), little skate (*L. erinacea*), barndoor skate (*Dipturus laevis*), thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), clearnose skate (*Raja eglanteria*), and rosette skate (*L. garmani*). Skates are currently managed under the New England Fishery Management Council's Skate Fishery Management Plan implemented in 2003. This plan includes mandatory reporting by species, possession prohibitions on barndoor, thorny, and smooth skates, trip limits for winter skate, and Annual Catch Limits (ACL) for the wing and bait fisheries.

Indices of relative abundance (stratified mean weight/tow) have been developed from Northeast Fisheries Science Center's (NEFSC) bottom trawl surveys for the seven species in the skate complex. These indices and their rates of change form the basis for all of the conclusions about the status of the complex. All statistically significant NEFSC gear, door, and vessel (RV *Delaware II* to RV *Albatross IV*) conversion factors were applied to little, winter, and smooth skate indices when applicable. The calibration coefficients (FSV *Henry B. Bigelow* to RV *Albatross IV*) below represent changes in overall catch rates expressed in terms of average weight per tow and these were accepted by the New England Fishery Management Council's (NEFMC) Science and Statistical Committee (SSC). All values for survey catch/tow in **Table 1** and **Figure 1** are expressed in "Albatross" units. The survey, range of years, and survey strata sets used as the basis of biological reference points for each species are given in **Table 1**. These strata sets were revised and accepted by the NEFMC SSC in 2011. The changes to the strata sets resulted in changes to biomass reference point values for all species except rosette skate, as well as a change to the overfishing reference point value for clearnose skate.

Calibration coefficients for seven skate species captured during NEFSC bottom trawl surveys:

Species	Calibration Coefficient (Std Err)*	Comment
Little <i>Leucoraja erinacea</i>	2.785519 (0.32)	Spring Survey
Winter <i>Leucoraja ocellata</i>	2.174334 (0.31)	Fall Survey
Barndoor <i>Dipturus laevis</i>	3.661128 (0.51)	Fall Survey
Thorny <i>Amblyraja radiata</i>	3.626359 (0.58)	Fall Survey
Smooth <i>Malacoraja senta</i>	4.449518 (0.67)	Fall Survey
Clearnose <i>Raja eglanteria</i>	6.189401 (0.81)	Fall Survey
Rosette <i>Leucoraja garmani</i>	8.813973 (0.98)	Based on the calibration coefficient for little skate in the fall survey comparisons

\*Calibration coefficients represent the ratio of *Bigelow* to *Albatross* catch weight per tow.

Biomass reference points are based entirely on NEFSC survey data, as reliable landings and discard information are not available by species. For all species except barndoor, the  $B_{MSY}$  proxy is defined as the 75<sup>th</sup> percentile of the appropriate survey biomass index time series for that species (**Table 1**). For barndoor skate, the  $B_{MSY}$  proxy is defined as the average of 1963-1966 fall survey biomass indices since the survey did not catch barndoor for a protracted period.

Bottom trawl surveys in fall 2014-2016 and spring 2015-18 were complete. However, ship problems delayed the start of the 2014 spring survey until late March and a decision was made, for that survey only, to drop any strata south of Delaware (Offshore 61-68; Inshore 32, 35, 38, 41, and 44). The consequences of the delay were relatively minor for assessment of the skate complex overall because only the little skate assessment relies on the spring survey. Because the status determination criteria for little skate are based on 3-year survey averages, the 2014 spring survey value will enter into the little skate stock status calculation in 2015 and in 2016. The time series trends without the southern strata are very similar to the full assessment strata set and are generally within the 95% confidence limits of each series (**Figure 2**). Based on survey data from multiple years, the ratio between the survey index from the smaller (truncated) strata set and the full strata set is 1.091 kg/tow. Therefore, the estimated little skate index for spring 2014 was adjusted downward (i.e., divided) by this factor to account for the difference in spatial coverage that year. Some caution should be exercised when interpreting this value.

The spring 2016 survey was complete but delayed by several weeks. The mean Julian Day from 1982-2013 ranged from 80-103. In 2014-2016, the mean Julian Days were 121, 99, and 130. It is unknown what impact this has on the little skate survey results.

The 2017 fall survey was incomplete and only strata from the Gulf of Maine and Georges Bank were completed (Offshore Strata 13-30, 36-40). This has major consequences for the skate complex. For two species, rosette skate and clearnose skate, there is no survey index for fall 2017. For the remaining species which use the fall survey, a ratio similar to that used for little skate in 2014 was used to adjust the survey index to account for the missing strata. For these species, the majority of the stock happens to occur in the strata that were sampled, so the consequences were not as great as for the other two species.

For winter skate, barndoor skate, thorny skate and smooth skate, the lack of coverage in the Southern New England and the Mid-Atlantic strata described above for fall 2017 was analyzed for the entire time series to show the difference between including and excluding these strata on the estimate of mean biomass. In general, all four species of skate are more abundant in the northern strata. Thus relative biomass estimates (catch per tow) based on the northern strata only will be higher than estimates based on the entire strata set. Over the entire time series (1967-2016 or 1963-2016) the ratios of the time series without the southern strata to the full strata set are 1.729, 1.251, 1.458, and 1.382, respectively. To adjust the observed 2017 value for these average ratios, the 2017 values of 14.464, 1.983, 0.299, and 0.454 were divided by 1.729, 1.251, 1.458, and 1.382 yielding values of 8.36, 1.58, 0.21, and 0.33.

The fishing mortality reference points are based on changes in survey biomass indices. If the three-year moving average of the survey biomass index for a skate species declines by more than the average CV of the survey time series, then fishing mortality is assumed to be greater than  $F_{MSY}$  and overfishing is occurring for that skate species. The average CVs of the indices are given by species in **Table 1**.

For winter skate, the 2015-2017 NEFSC fall average biomass index of 7.12 kg/tow is above the biomass threshold reference point (2.83 kg/tow) and above the  $B_{MSY}$  proxy (5.66 kg/tow). The 2015-2017 average index is above the 2014-2016 index by 7.1%. It is recommended that this stock is not overfished and overfishing is not occurring.

For little skate, the 2016-2018 NEFSC spring average biomass index of 4.69 kg/tow is above the biomass threshold reference point (3.07 kg/tow) but below the  $B_{MSY}$  proxy (6.15 kg/tow). The 2016-2018 average index is below the 2015-2017 average by 14.6% which is less than the threshold percent change of 20%. It is recommended that this stock is not overfished and overfishing is not occurring.

For barndoor skate, the 2015-2017 NEFSC fall average survey biomass index of 1.59 kg/tow is above the biomass threshold reference point (0.78 kg/tow) and the  $B_{MSY}$  proxy (1.57 kg/tow). The 2015-2017 average index is below the 2014-2016 index by 0.7%. It is recommended that this stock is not overfished and overfishing is not occurring.

For thorny skate, the 2015-2017 NEFSC fall average biomass index of 0.175 kg/tow is well below the biomass threshold reference point (2.06 kg/tow). The 2015-2017 index is below the 2014-2016 index by 0.6%. It is recommended that this stock is overfished but overfishing is not occurring.

For smooth skate, the 2015-2017 NEFSC fall average biomass index of 0.285 kg/tow is above the biomass threshold reference point (0.134 kg/tow) and the  $B_{MSY}$  proxy (0.27 kg/tow). The 2015-2017 index is above the 2014-2016 index by 14.5%. It is recommended that this stock is not overfished and is rebuilt and overfishing is not occurring.

For clearnose skate, there is no 2017 survey to update, therefore stock status cannot be updated. The 2014-2016 NEFSC fall average biomass index of 0.59 kg/tow was above the biomass threshold reference point (0.33 kg/tow) but below the  $B_{MSY}$  proxy (0.66 kg/tow). The 2014-2016 index was below the 2013-2015 index by 19.5% which is less than the threshold percent change of 40%. It was recommended in 2016 that this stock was not overfished and overfishing was not occurring.

For rosette skate, there is no 2017 survey to update, therefore stock status cannot be updated. The 2014-2016 NEFSC fall average biomass index of 0.047 kg/tow was above the biomass threshold reference point (0.024 kg/tow) but below the  $B_{MSY}$  proxy (0.048 kg/tow). The 2014-2016 index was below the 2013-2015 index by 7.9% which was less than the threshold percent change of 60%. It was recommended in 2016 that this stock was not overfished and overfishing was not occurring.

### **Update of Bait Landings and Total Discards**

Landings of bait that are sold from boat-to-boat have ranged from 419 mt in 2016 to 3464 mt in 1999 (**Table 2**). They were 193 in 2017. Total discards were updated through 2017 (**Tables 4-6**). Discards in the Gulf of Maine to Georges Bank region declined from 2016 and are the lowest in the time series at 10,289 mt. Discards in Southern New England to the Mid-Atlantic region declined from 2016 to 15,086 which is the lowest since 2001 and the fourth lowest in the time series. Overall, discards declined by 24% from 33,270 mt to 25,365 mt in 2017, the lowest value in the time series.

### **References**

Miller TJ, Das C, Politis PJ, Miller AS, Lucey SM, Legault CM, Brown RW, Rago PJ. 2010. Estimation of Albatross IV to Henry B. Bigelow calibration factors. Northeast Fish Sci Cent Ref Doc. 10-05; 233 p.

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	BARNDOR	CLEARNOSE	LITTLE	ROSETTE	SMOOTH	THORNY	WINTER
Survey (kg/tow)	Fall	Fall	Spring	Fall	Fall	Fall	Fall
Time Series Basis	1963-1966	1975-2007	1982-2008	1967-2007	1963-2007	1963-2007	1967-2007
Strata Set	Offshore 1-30, 34-40	Offshore 61-76, Inshore 17,20,23,26,29,32,35,38,41,44	Offshore 1-30, 34-40, 61-76, Inshore 2,5,8,11,14,17,20,23,26,29,32,35,38,41,44-46,56,59-61,64-66	Offshore 61-76	Offshore 1-30, 34-40	Offshore 1-30, 34-40	Offshore 1-30, 34-40, 61-76
2011	1.02	1.32	6.88	0.034	0.30	0.18	6.65
2012	1.54	0.93	7.54	0.040	0.21	0.08	5.29
2013	1.07	0.77	6.90	0.056	0.14	0.11	2.95
2014	1.62	0.61	6.54 <sup>a</sup>	0.053	0.22	0.21	6.95
2015	2.08	0.82	6.82	0.045	0.25	0.19	6.15
2016	1.09	0.34	3.56 <sup>b</sup>	0.044	0.27	0.13	6.84
2017	1.58 <sup>c</sup>	°	6.09	°	0.33 <sup>c</sup>	0.21 <sup>c</sup>	8.36 <sup>c</sup>
2018			4.41				
2011-2013 3-year average	1.21	1.01	7.11	0.042	0.22	0.12	4.96
2012-2014 3-year average	1.41	0.77	6.99 <sup>a</sup>	0.048	0.19	0.13	5.06
2013-2015 3-year average	1.59	0.73	6.75 <sup>a</sup>	0.051	0.21	0.17	5.35
2014-2016 3-year average	1.60	0.59	5.64 <sup>b</sup>	0.047	0.25	0.176	6.65
2015-2017 3-year average	1.59 <sup>c</sup>	°	5.49	°	0.285 <sup>c</sup>	0.175 <sup>c</sup>	7.12 <sup>c</sup>
2016-2018 3-year average			4.69				
Percent change 2012-2014 compared to 2011-2013	+16.5	-23.3	-1.6	+14.6	-12.5	+8.7	+2.0
Percent change 2013-2015 compared to 2012-2014	+12.9	-4.8	-3.4	+6.0	+6.8	+26.3	+5.7
Percent change 2014-2016 compared to 2013-2015	+0.5	-19.5	-16.8	-7.9	+21.4	+3.7	+24.2
Percent change 2015-2017 compared to 2014-2016	-0.7		-2.6		+14.5	-0.6	+7.1
Percent change 2016-2018 compared to 2015-2017			-14.6				
Percent change for overfishing status determination in FMP	-30	-40	-20	-60	-30	-20	-20
Biomass Target	1.57	0.66	6.15	0.048	0.27	4.13	5.66
Biomass Threshold	0.78	0.33	3.07	0.024	0.13	2.06	2.83

**Table 1.** a. No survey tows completed south of Delaware in spring 2014. Values for 2014 were adjusted for missing strata (i.e., Offshore 61-68, inshore 32,35,38,41,44) but may not be fully comparable to other surveys which sampled all strata. b. The 2016 spring survey was later than usual. Footnote c. No survey tows completed south of Georges Bank in fall 2017. Values were adjusted for missing strata (Offshore 1-12,61-76).

Table 2. Landings (mt, live wt) of skate reported on VTRs as sold from boat to boat as bait.

<b>Year</b>	<b>Landings</b>
1994	681.0
1995	760.7
1996	1326.7
1997	1685.7
1998	2418.4
1999	3464.1
2000	2652.1
2001	2768.1
2002	1735.7
2003	1249.0
2004	991.5
2005	771.6
2006	1010.8
2007	1206.2
2008	1245.2
2009	1508.5
2010	884.0
2011	676.2
2012	616.0
2013	689.5
2014	588.4
2015	1016.3
2016	419.1
2017	193.4

Table 3. Estimated discards (mt) of skates (all species) by gear type taken in the Gulf of Maine-Georges Bank region, 1964-2017.

year	Half 1						Total Half 1	Half 2						Total Half 2	Grand Total
	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge			Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge			
1964	361	36,599	0	12	6,433	43,404	402	22,820		7	7,825	31,054	74,458		
1965	425	37,899	0	17	2,588	40,928	491	24,325		5	642	25,462	66,390		
1966	311	39,141	0	26	730	40,208	625	22,370		7	1,562	24,565	64,772		
1967	319	29,986	0	22	610	30,936	470	19,144		8	2,578	22,201	53,137		
1968	224	25,468	0	37	766	26,496	414	18,033		10	1,862	20,318	46,814		
1969	295	24,422	0	32	1,048	25,796	668	15,907		6	2,282	18,863	44,660		
1970	329	22,184	0	22	1,346	23,881	584	15,206		7	2,163	17,960	41,841		
1971	517	21,090	0	21	1,818	23,446	769	14,939		8	1,806	17,522	40,968		
1972	523	18,889	0	31	1,181	20,624	711	12,399		13	1,915	15,038	35,662		
1973	605	18,957	0	31	1,724	21,317	718	13,556		15	1,664	15,954	37,271		
1974	664	17,180	0	58	1,106	19,007	763	11,945		24	1,521	14,253	33,260		
1975	693	15,315	283	61	1,331	17,683	729	11,790	36	26	2,243	14,823	32,506		
1976	495	14,747	66	99	1,705	17,111	429	12,138	0	37	3,229	15,833	32,944		
1977	319	19,178	39	169	3,631	23,336	310	14,145	0	47	8,122	22,625	45,961		
1978	580	22,489	0	189	4,468	27,727	446	14,380	0	66	9,135	24,028	51,754		
1979	905	22,301	26	156	5,673	29,061	760	16,610	0	67	9,967	27,403	56,464		
1980	833	28,089	23	194	7,452	36,590	187	18,063	0	96	8,353	26,699	63,289		
1981	260	29,358	92	262	8,467	38,439	88	15,640	0	93	11,769	27,590	66,029		
1982	254	26,373	117	94	6,054	32,893	96	19,492	7	83	9,578	29,258	62,151		
1983	340	29,158	116	117	4,983	34,715	140	16,464	22	69	6,869	23,565	58,280		
1984	282	27,426	152	125	3,458	31,444	30	13,638	53	94	5,229	19,043	50,488		
1985	240	21,701	214	117	2,279	24,551	86	10,746	70	81	5,794	16,778	41,329		
1986	275	18,687	256	171	4,247	23,637	72	8,855	83	87	7,322	16,419	40,056		
1987	567	15,012	264	141	4,098	20,081	260	8,271	46	85	8,981	17,644	37,725		
1988	539	16,809	158	163	6,472	24,142	324	8,409	46	90	11,846	20,714	44,856		
1989	483	18,497	73	56	6,567	25,676	236	8,722	17	92	13,149	22,216	47,892		
1990	347	22,874	223	347	7,560	31,352	237	9,910	71	73	18,614	28,905	60,256		
1991	729	11,624	232	99	10,858	23,542	234	8,680	44	113	12,297	21,367	44,909		
1992	1,658	8,056	255	162	9,879	20,009	893	2,848	0	56	13,873	17,670	37,679		
1993	28	4,528	35	119	5,024	9,734	22	11,686	1	65	5,819	17,591	27,325		
1994	26	4,759	11	130	1,877	6,802	25	10,295	1	72	1,853	12,246	19,048		
1995	25	7,359	8	209	405	8,006	26	2,317	1	259	1,307	3,909	11,915		
1996	21	7,506	26	279	739	8,572	21	1,743	8	65	2,789	4,625	13,197		
1997	20	4,378	34	106	1,642	6,180	21	3,816	4	16	2,796	6,653	12,833		
1998	17	3,197	9	50	3,399	6,672	24	6,290	1	56	4,278	10,650	17,322		
1999	19	1,689	4	98	1,004	2,815	21	7,055	0	110	3,093	10,280	13,095		
2000	11	4,531	6	121	2,558	7,227	22	7,650	0	740	1,386	9,798	17,025		
2001	15	19,301	0	188	472	19,975	16	6,310		153	555	7,034	27,009		
2002	17	11,090	1	135	944	12,187	20	5,783		200	2,040	8,043	20,230		

Table 3. cont

year	Half 1						Total Half 1	Line Trawl	Half 2					Total Half 1	Grand Total
	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge				Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge			
2003	32	11,666	8	254	1,132	13,092	13	9,875		153	1,731	11,772	24,864		
2004	3	11,476	4	269	317	12,069	10	13,927	0	219	1,044	15,201	27,270		
2005	88	9,482	2	399	589	10,561	51	12,773	0	204	2,238	15,267	25,828		
2006	54	8,082	0	173	1,059	9,369	17	9,408	1	294	2,482	12,202	21,570		
2007	70	10,577	0	359	892	11,897	22	10,870	0	360	3,179	14,431	26,328		
2008	69	6,662	2	139	1,549	8,420	13	8,648	0	302	2,136	11,099	19,519		
2009	60	7,109	1	563	1,155	8,889	48	10,573	0	203	1,401	12,224	21,113		
2010	143	7,421	0	94	291	7,950	46	9,038	0	274	1,031	10,390	18,340		
2011	89	7,672	3	153	269	8,187	55	8,538	0	257	1,963	10,813	18,999		
2012	29	5,170	3	114	1,140	6,456	25	7,103	0	127	2,597	9,853	16,310		
2013	26	4,205	0	67	1,541	5,839	79	9,182	0	211	2,159	11,631	17,470		
2014	11	5,158		45	1,236	6,449	107	6,083		262	2,476	8,929	15,378		
2015	9	4,094		47	3,166	7,316	287	7,524		276	1,393	9,480	16,796		
2016	5	2,303		113	1,637	4,058	70	6,269		286	1,499	8,124	12,182		
2017	8	1,690	0	55	1,726	3,479	39	4,493	0	288	1,989	6,809	10,289		



Table 4. Estimated discards (mt) of skates (all species) by gear type taken in the Southern New England-Mid-Atlantic region, 1964-2017.

Year	Half 1						Half 2						Grand Total
	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	
1964	0	16,916		0	1	16,917	0	15,172		0	463	15,635	32,552
1965	0	20,746		0	2,441	23,187	0	16,887		0	8,298	25,185	48,372
1966	0	23,680		0	4,813	28,494	0	13,499		0	4,961	18,460	46,954
1967	0	26,886		0	2,273	29,159	0	15,909		0	2,157	18,066	47,225
1968	0	30,741		0	2,905	33,646	0	15,978		0	3,028	19,006	52,652
1969	2	30,557		0	1,246	31,805	1	13,392		0	735	14,128	45,933
1970	2	21,694		0	492	22,188	0	11,596		0	579	12,175	34,363
1971	2	13,419		0	98	13,519	0	5,158		0	746	5,904	19,422
1972	2	13,272		0	819	14,094	1	5,566		0	644	6,210	20,304
1973	13	15,425		0	379	15,816	6	6,182		0	182	6,369	22,185
1974	34	19,170		0	888	20,091	15	5,810		0	1,324	7,148	27,239
1975	34	9,882		0	1,284	11,200	15	5,522		0	2,515	8,052	19,252
1976	19	7,688		0	2,381	10,089	11	7,512		0	5,085	12,608	22,697
1977	10	7,639		0	3,579	11,228	4	7,534		0	1,984	9,521	20,750
1978	248	12,605		1	4,580	17,434	215	9,103		0	5,317	14,635	32,069
1979	114	16,229		1	3,513	19,857	211	11,372		0	3,574	15,157	35,014
1980	224	11,730		1	2,448	14,403	167	11,570		0	2,750	14,487	28,890
1981	244	13,828		1	1,036	15,108	169	10,820		0	1,049	12,038	27,147
1982	146	17,088		1	1,725	18,960	101	18,388		0	2,994	21,483	40,442
1983	131	20,196		1	3,672	23,999	86	17,247		0	5,096	22,429	46,428
1984	95	21,023		1	4,879	25,998	57	17,623		1	4,674	22,354	48,353
1985	80	18,452		2	4,542	23,076	87	12,760		0	3,689	16,536	39,612
1986	132	18,225		2	3,574	21,932	99	16,662		1	4,758	21,520	43,452
1987	126	21,129		2	8,589	29,846	104	12,907		1	9,972	22,984	52,829
1988	98	18,544		3	7,319	25,964	17	12,771		1	7,231	20,020	45,984
1989	59	19,166		18	11,639	30,882	28	11,537		20	6,303	17,887	48,769
1990	43	26,989		0	9,602	36,634	37	29,098		0	4,844	33,978	70,612
1991	110	11,258		0	8,457	19,824	63	8,799		0	6,515	15,377	35,201
1992	392	5,763		107	3,800	10,062	377	16,761		51	8,950	26,139	36,202
1993	14	3,358		92	6,243	9,708	6	15,139		45	6,881	22,072	31,780
1994	7	52,689		60	4,607	57,363	3	7,561		158	3,768	11,490	68,853
1995	5	14,621		234	6,980	21,840	4	8,898		91	18,174	27,167	49,007
1996	7	8,716		135	7,636	16,494	6	28,879		60	8,469	37,413	53,908
1997	10	3,207		282	8,488	11,986	8	3,582		74	3,264	6,928	18,914
1998	8	2,906		168	5,670	8,752	6	4,198		196	4,264	8,665	17,417
1999	4	966		500	7,537	9,007	3	2,802		150	3,056	6,011	15,018
2000	3	2,252		60	6,466	8,782	4	10,525		51	3,573	14,153	22,935
2001	5	773		216	3,143	4,138	6	2,138		54	2,694	4,893	9,031
2002	4	1,078		256	5,711	7,050	5	4,284		2,519	6,006	12,814	19,863

Table 4. cont

year	Half 1						Total Half 1	Line Trawl	Half 2					Total Half 1	Grand Total
	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge				Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge			
2003	6	6,592		269	6,090	12,957	6	7,854		289	6,234	14,382	27,339		
2004	6	2,848		181	5,227	8,261	6	7,809		284	3,192	11,290	19,552		
2005	0	4,822		642	5,823	11,287	0	6,496		355	2,507	9,359	20,646		
2006	1	2,470		680	3,720	6,872	1	2,960		68	3,092	6,121	12,993		
2007	0	3,990		631	4,920	9,541	0	5,345		396	3,309	9,050	18,591		
2008	49	3,729		1,093	3,261	8,132	43	4,490		442	2,403	7,378	15,511		
2009	104	3,944		1,070	3,748	8,867	137	4,125		406	2,792	7,461	16,328		
2010	125	2,040		963	7,364	10,493	163	2,834		1,070	3,865	7,932	18,425		
2011	83	4,095		1,823	4,794	10,795	116	6,222		948	1,678	8,965	19,760		
2012	17	4,771		1,543	3,075	9,405	27	6,283		697	1,551	8,559	17,964		
2013	282	10,239		1,334	2,106	13,961	375	7,758		312	2,798	11,243	25,203		
2014	3	7,476		1,630	6,279	15,388	4	8,344		618	3,025	11,991	27,378		
2015	50	7,503		929	2,933	11,415	20	7,081		421	2,163	9,684	21,099		
2016	81	5,786		1,135	3,184	10,187	62	5,959		328	4,552	10,901	21,088		
2017	46	3,815		945	3,203	8,010	38	3,113		396	3,520	7,066	15,076		

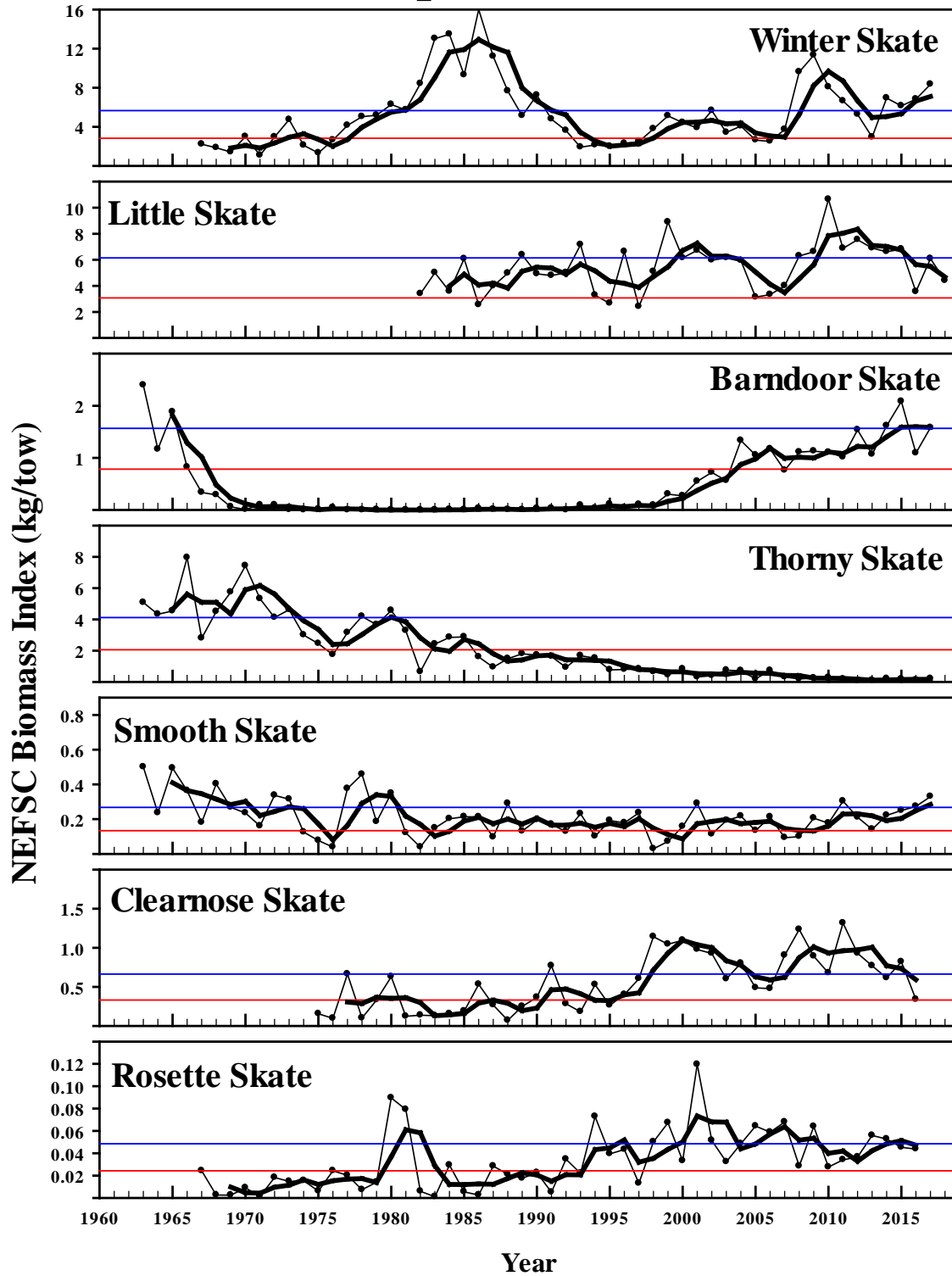
Table 5. Estimated discards (mt) of skates (all species) by gear type from all areas combined, 1964-2017.

Year	Half 1						Half 2						Grand Total
	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	
1964	361	53,514	0	12	6,434	60,321	402	37,992	0	7	8,288	46,690	107,011
1965	425	58,644	0	17	5,029	64,115	491	41,212	0	5	8,940	50,647	114,762
1966	311	62,821	0	26	5,543	68,701	625	35,869	0	7	6,524	43,025	111,726
1967	319	56,872	0	22	2,882	60,095	470	35,053	0	8	4,735	40,267	100,362
1968	224	56,209	0	37	3,672	60,142	414	34,010	0	10	4,890	39,324	99,466
1969	296	54,979	0	32	2,294	57,602	669	29,299	0	6	3,017	32,991	90,593
1970	331	43,878	0	22	1,838	46,069	584	26,802	0	7	2,742	30,135	76,204
1971	519	34,509	0	21	1,916	36,965	769	20,097	0	8	2,552	23,426	60,391
1972	525	32,161	0	31	2,000	34,718	711	17,965	0	13	2,559	21,248	55,966
1973	618	34,382	0	31	2,103	37,134	724	19,738	0	15	1,846	22,323	59,457
1974	697	36,349	0	58	1,994	39,099	778	17,754	0	24	2,845	21,401	60,499
1975	727	25,197	283	61	2,615	28,883	744	17,313	36	26	4,757	22,875	51,758
1976	514	22,435	66	99	4,086	27,200	441	19,650	0	37	8,313	28,441	55,641
1977	329	26,817	39	169	7,210	34,564	314	21,679	0	47	10,106	32,146	66,710
1978	829	35,094	0	190	9,048	45,161	661	23,484	0	66	14,452	38,662	83,823
1979	1,019	38,530	26	157	9,186	48,918	971	27,982	0	67	13,540	42,560	91,478
1980	1,056	39,819	23	195	9,900	50,993	354	29,633	0	96	11,104	41,186	92,179
1981	503	43,186	92	264	9,502	53,547	257	26,460	0	93	12,818	39,628	93,175
1982	400	43,461	117	95	7,779	51,853	197	37,880	7	84	12,572	50,740	102,593
1983	471	49,354	116	118	8,655	58,714	226	33,711	22	70	11,965	45,994	104,708
1984	378	48,449	152	126	8,337	57,442	87	31,261	53	94	9,903	41,398	98,840
1985	321	40,153	214	119	6,821	47,628	173	23,506	70	81	9,483	33,314	80,941
1986	406	36,913	256	173	7,821	45,569	171	25,517	83	88	12,080	37,938	83,508
1987	692	36,141	264	143	12,687	49,927	364	21,178	46	86	18,953	40,627	90,554
1988	638	35,353	158	166	13,791	50,106	341	21,180	46	91	19,077	40,734	90,840
1989	542	37,663	73	74	18,206	56,558	264	20,260	17	111	19,452	40,104	96,661
1990	390	49,863	223	347	17,162	67,986	273	39,008	71	73	23,458	62,883	130,869
1991	839	22,882	232	99	19,314	43,366	297	17,478	44	113	18,812	36,744	80,110
1992	2,050	13,819	255	269	13,679	30,072	1,270	19,609	0	107	22,823	43,809	73,881
1993	42	7,886	35	211	11,268	19,442	28	26,825	1	110	12,700	39,663	59,105
1994	33	57,447	11	190	6,484	64,165	28	17,856	1	230	5,621	23,735	87,900
1995	30	21,980	8	443	7,385	29,846	30	11,215	1	350	19,481	31,077	60,922
1996	28	16,222	26	414	8,376	25,066	27	30,622	8	125	11,258	42,039	67,105
1997	30	7,584	34	388	10,130	18,166	30	7,398	4	90	6,059	13,581	31,747
1998	25	6,103	9	218	9,069	15,425	30	10,488	1	252	8,543	19,314	34,739
1999	23	2,655	4	598	8,542	11,823	24	9,857	0	261	6,149	16,291	28,113
2000	14	6,783	6	181	9,024	16,009	26	18,175	0	791	4,959	23,951	39,960
2001	20	20,075	0	404	3,615	24,114	22	8,449	0	207	3,249	11,927	36,040
2002	21	12,168	1	392	6,655	19,237	25	10,067	0	2,718	8,046	20,857	40,094

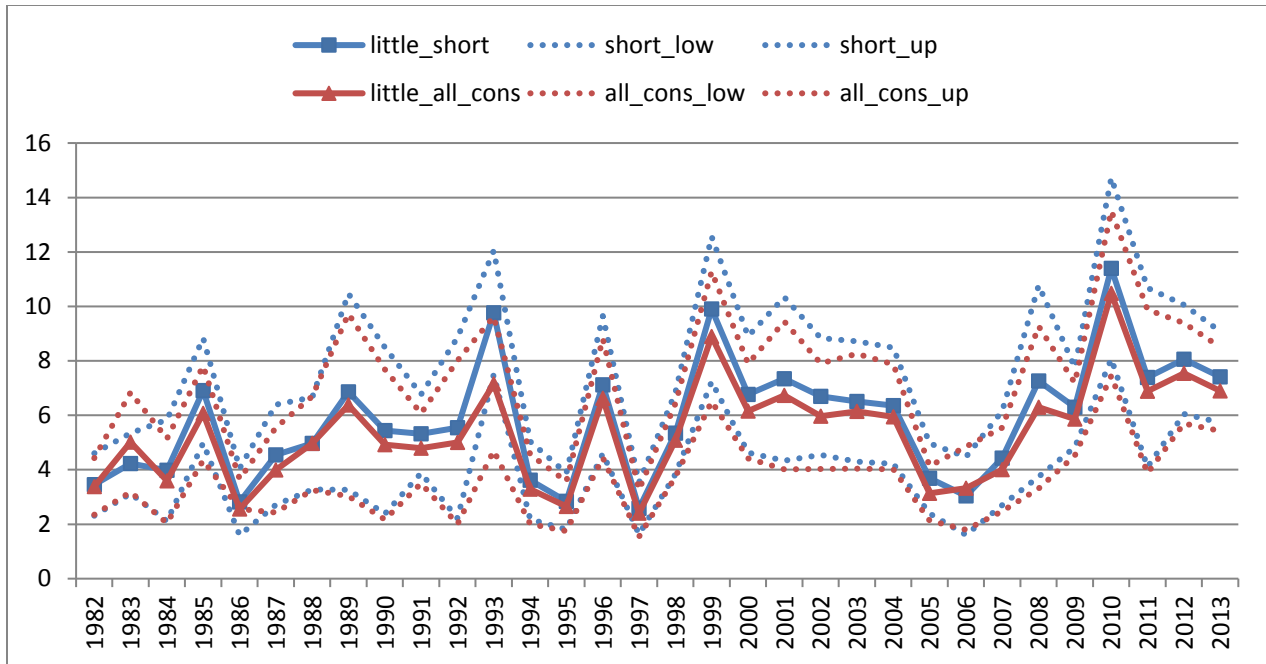
Table 5. cont

year	Half 1						Total Half 1	Line Trawl	Half 2					Total Half 1	Grand Total
	Line Trawl	Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge	Line Trawl			Otter Trawl	Shrimp Trawl	Sink Gill Net	Scallop Dredge			
2003	38	18,258	8	522	7,222	26,048	18	17,728	0	442	7,965	26,154	52,203		
2004	9	14,324	4	450	5,544	20,331	16	21,736	0	503	4,236	26,491	46,822		
2005	88	14,304	2	1,041	6,412	21,848	51	19,269	0	559	4,746	24,626	46,473		
2006	55	10,552	0	854	4,779	16,241	18	12,368	1	362	5,574	18,323	34,564		
2007	70	14,566	0	990	5,812	21,438	22	16,214	0	756	6,488	23,481	44,919		
2008	119	10,391	2	1,232	4,810	16,553	56	13,138	0	744	4,539	18,478	35,030		
2009	164	11,054	1	1,634	4,903	17,756	185	14,698	0	609	4,193	19,685	37,441		
2010	269	9,461	0	1,058	7,655	18,443	209	11,872	0	1,344	4,896	18,322	36,765		
2011	172	11,768	3	1,976	5,063	18,982	171	14,760	0	1,205	3,642	19,777	38,759		
2012	46	9,941	3	1,657	4,215	15,861	53	13,386	0	825	4,149	18,412	34,274		
2013	308	14,444	0	1,401	3,647	19,800	454	16,940	0	523	4,957	22,874	42,673		
2014	14	12,634	0	1,675	7,514	21,837	111	14,427	0	880	5,502	20,919	42,757		
2015	60	11,596	0	976	6,099	18,731	307	14,605	0	696	3,556	19,164	37,895		
2016	86	8,090	0	1,248	4,821	14,245	132	12,228	0	614	6,051	19,025	33,270		
2017	55	5,505	0	1,000	4,929	11,489	76	7,606	0	684	5,509	13,876	25,365		

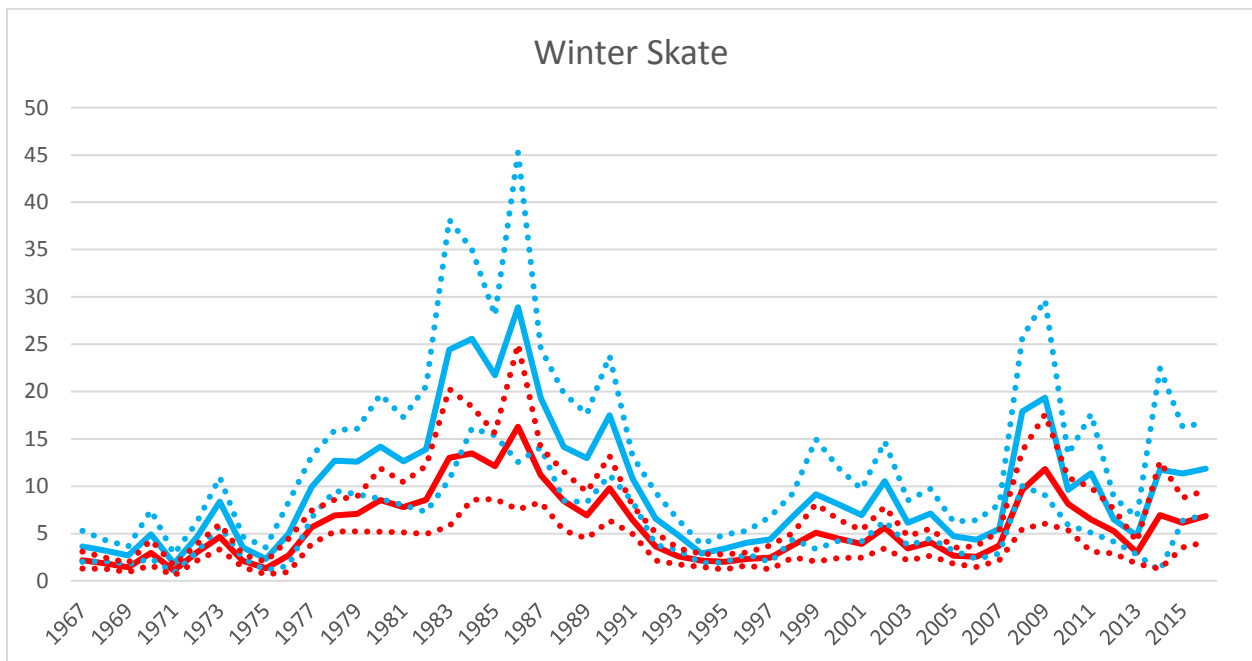
# Skate Complex Biomass Indices



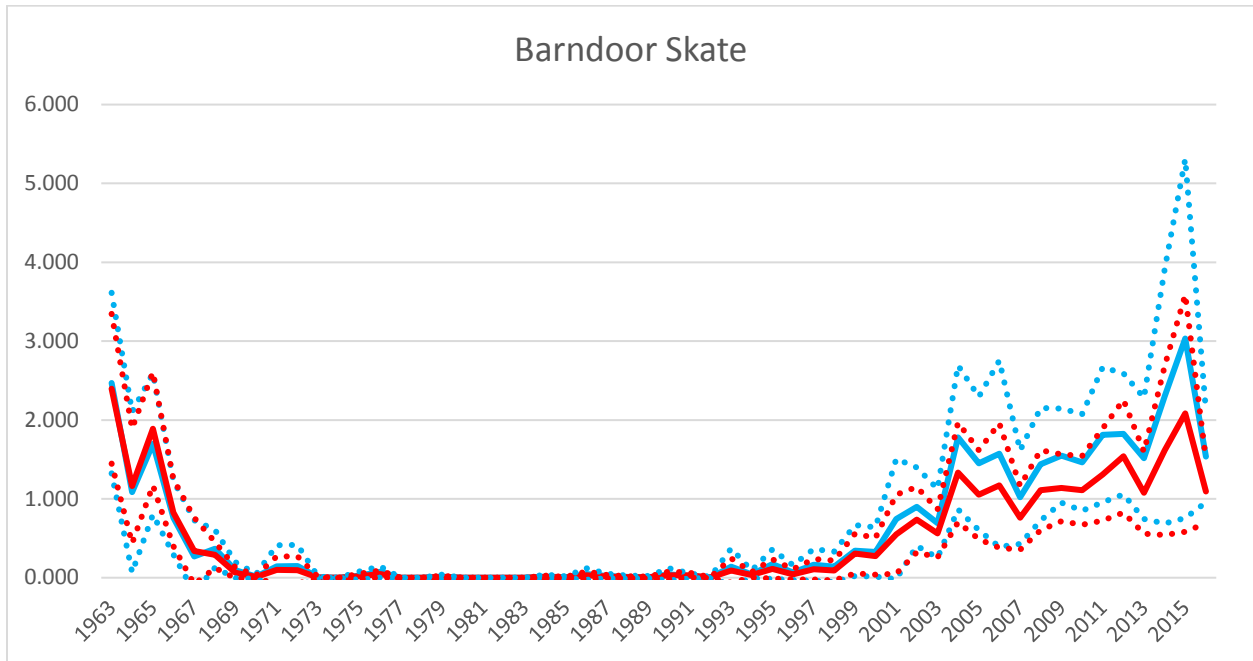
**Figure 1.** NEFSC survey biomass indices (kg/tow). Thin lines with symbols are annual indices, thick lines are 3-year moving averages, and the thin horizontal lines are the biomass thresholds and targets developed through 2007/2008 with consistent strata sets.



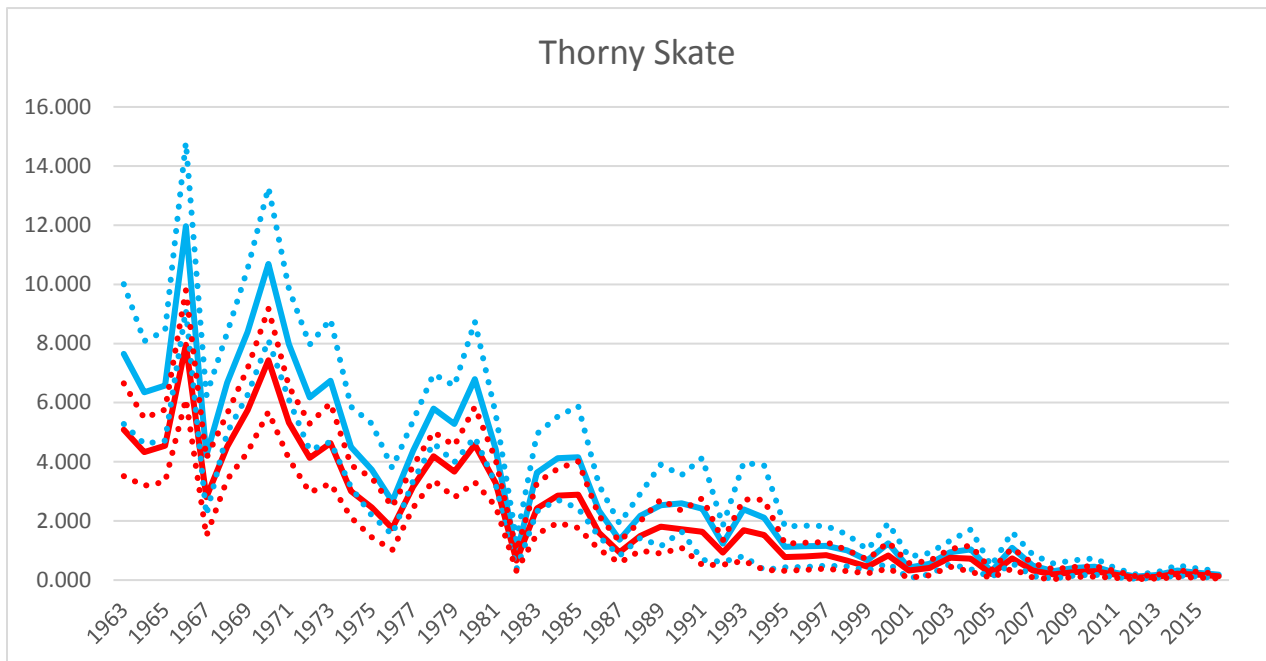
**Figure 2.** Little skate spring indices (kg per tow) based on all strata (i.e., full strata set; red triangles) and based on truncated strata set (i.e., strata south of Delaware Bay were removed; blue squares) from 1982-2013. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.091 (based on a ratio estimator = sum across years of survey estimates based on truncated series divided by sum of estimates based on full strata set).



**Figure 3.** Winter skate fall indices (kg per tow) based on all offshore strata (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1967-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.729 (based on a ratio estimator = sum across years of survey estimates based on truncated series divided by sum of estimates based on full strata set).

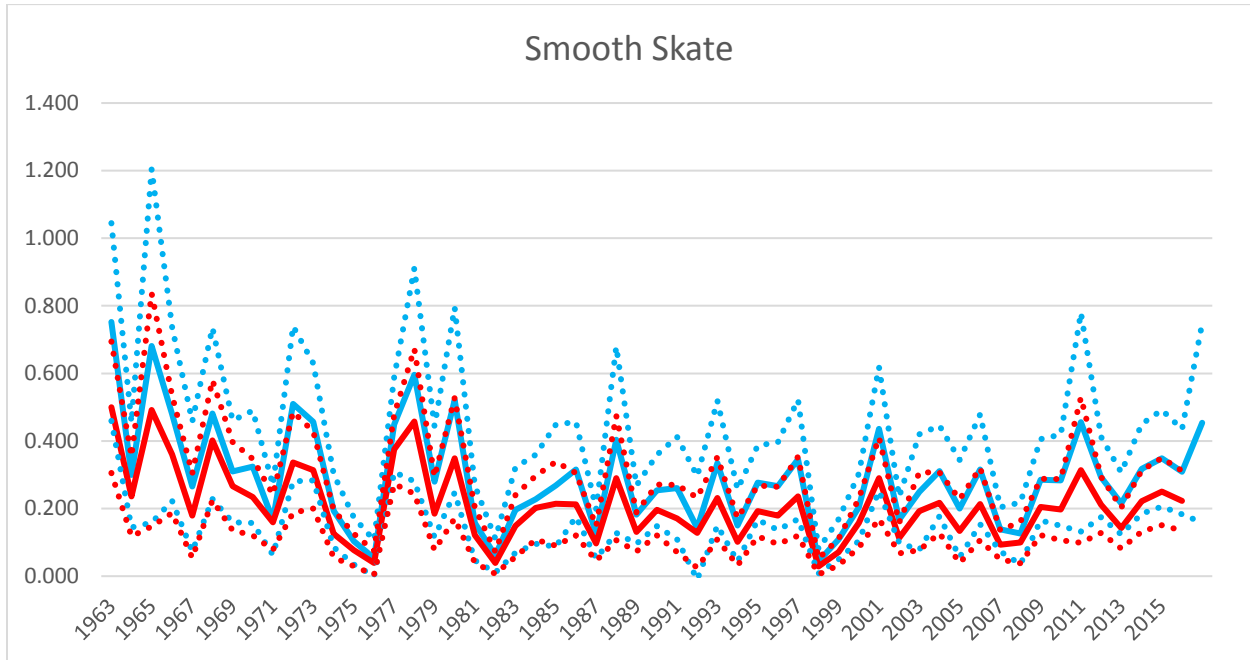


**Figure 4.** Barndoor skate fall indices (kg per tow) based on offshore strata (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.252 (based on a ratio estimator = sum across years of survey estimates based on truncated series divided by sum of estimates based on full strata set).



**Figure 5.** Thorny skate fall indices (kg per tow) based on offshore strata (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata

set is 1.458 (based on a ratio estimator = sum across years of survey estimates based on truncated series divided by sum of estimates based on full strata set).



**Figure 6.** Smooth skate fall indices (kg per tow) based on offshore strata (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.382 (based on a ratio estimator = sum across years of survey estimates based on truncated series divided by sum of estimates based on full strata set).