

## 2019 NE Skate Stock Status Update (NEFSC, Lead Analyst: K. Sosebee, 7/10/2020)

Seven species of skates occur along the North Atlantic coast of the United States: barndoor skate (*Dipturus laevis*), clearnose skate (*Raja eglanteria*), little skate (*Leucoraja erinacea*), rosette skate (*L. garmani*), smooth skate (*Malacoraja senta*), thorny skate (*Amblyraja radiata*), and winter skate (*L. ocellata*). Skates are currently managed under the New England Fishery Management Council's Skate Fishery Management Plan implemented in 2003. This plan has been changed over time and now includes mandatory reporting by species, possession prohibitions on thorny, and smooth skates, trip limits for the wing and bait fisheries, 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<sub>MSY</sub> proxy is defined as the 75<sup>th</sup> percentile of the appropriate survey biomass index time series for that species through fall 2007 or spring 2008 (**Table 1**). For barndoor skate, the B<sub>MSY</sub> 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 spring 2015-19 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; **Figures 2 and 3**). 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. 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 4**). Based on survey data from multiple years, the ratio between the survey indices 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.

Bottom trawl surveys in fall 2014-2016 and 2019 were complete. 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; **Figures 2 and 3**). This has major consequences for the skate complex. For two species, clearnose skate and rosette skate, there is no survey index for fall 2017 and a two-year average (2016+2018) was used in 2019 for stock status, even though alternatives were run in 2019 (**Figures 5 and 6**). 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 indices 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 barndoor skate, smooth skate, thorny skate, and winter 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 (kg/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, 1.223, 1.418, 1.423, and 1.610, respectively (**Figures 7-10**). To adjust the observed 2017 value for these average ratios, the 2017 values of 1.888, 0.476, 0.305, and 13.527 were divided by 1.223, 1.418, 1.423, and 1.610 yielding values of 1.54, 0.34, 0.21, and 8.40.

In fall 2018, offshore strata 30, 34, and 35 were not sampled and offshore stratum 36 only had 1 tow. This impacts barndoor skate, smooth skate, thorny skate, and winter skate. The same method as used for 2017 was used. The ratios were 0.998, 0.860, 0.996, and 1.051, respectively (**Figures 11-14**). Even though the values for barndoor and thorny skate were near one, these 4 factors were still applied to index values of 2.798, 0.214, 0.141, and 6.740 to yield modified values of 2.804, 0.249, 0.142 and 6.415, for consistency with previous years.

The spring 2020 survey only covered a small portion of the survey area due to the COVID-19 pandemic. Therefore there is no update of stock status for little skate.

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 (as percent change for overfishing status determination in FMP) by species in **Table 1**.

For barndoor skate, the 2017-2019 NEFSC fall average survey biomass index of 2.02 kg/tow is above the biomass threshold reference point (0.78 kg/tow) and the  $B_{MSY}$  proxy (1.57 kg/tow). The 2017-2019 average index is above the 2016-2018 index by 11.4%. It is recommended that this stock is not overfished and overfishing is not occurring.

For clearnose skate, the 2017-2019 NEFSC fall average biomass index of 1.05 kg/tow is above the biomass threshold reference point (0.33 kg/tow) and the  $B_{MSY}$  proxy (0.66 kg/tow). The 2017-2019 index is above the 2016 and 2018 index by 73.1%. It is recommended that this stock is not overfished and overfishing is not occurring.

For little skate, there is no 2017 survey to update, therefore stock status cannot be updated. For little skate, the 2017-2019 NEFSC spring average biomass index of 5.32 kg/tow is above the biomass threshold reference point (3.07 kg/tow) but below the  $B_{MSY}$  proxy (6.15 kg/tow). The 2017-2019 average index is above the 2016-2018 average by 13.4%. It was recommended in 2019 that this stock is not overfished and overfishing is not occurring.

For rosette skate, the 2017-2019 NEFSC fall average biomass index of 0.050 kg/tow was above the biomass threshold reference point (0.024 kg/tow) and above the  $B_{MSY}$  proxy (0.048 kg/tow). The 2017-2019 index is above the 2016 and 2018 index by 6.4%. It is recommended that this stock is not overfished and overfishing is not occurring.

For smooth skate, the 2017-2019 NEFSC fall average biomass index of 0.27 kg/tow is above the biomass threshold reference point (0.134 kg/tow) and at the  $B_{MSY}$  proxy (0.27 kg/tow). The 2017-2019 index is about equal to the 2016-2018 index. It is recommended that this stock is not overfished and is rebuilt and overfishing is not occurring.

For thorny skate, the 2017-2019 NEFSC fall average biomass index of 0.18 kg/tow is well below the biomass threshold reference point (2.06 kg/tow). The 2017-2019 index is above the 2016-2018 index by 11.4%. It is recommended that this stock is overfished but overfishing is not occurring.

For winter skate, the 2017-2019 NEFSC fall average biomass index of 8.61 kg/tow is above the biomass threshold reference point (2.83 kg/tow) and above the  $B_{MSY}$  proxy (5.66 kg/tow). The 2017-2019 average index is above the 2016-2018 index by 19.2%. It is recommended that this stock is not overfished and overfishing is not occurring.

## 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.

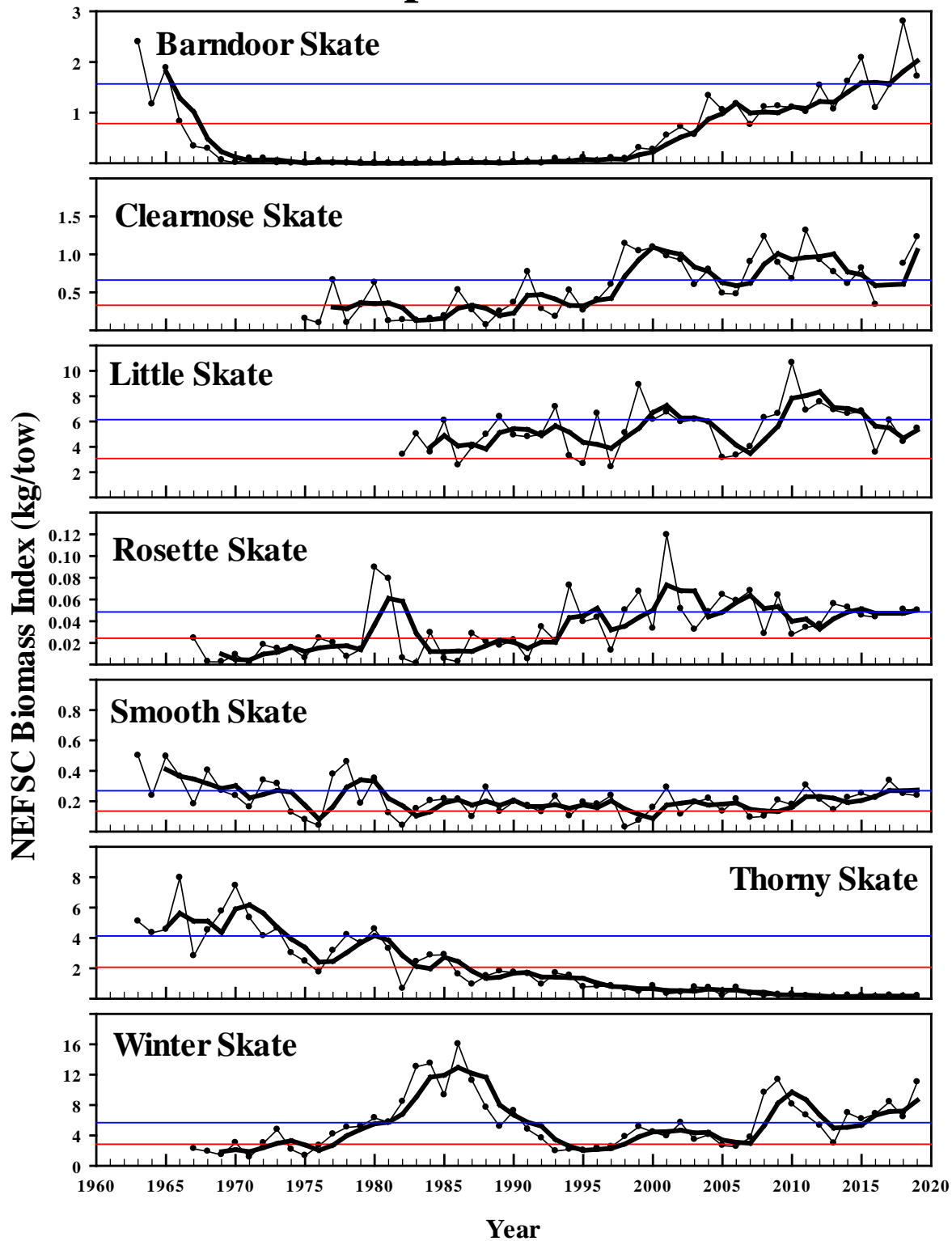
Sosebee K, Miller A, O'Brien L, McElroy D, Sherman S. 2016. Update of Thorny Skate, *Amblyraja radiata*, Commercial and Survey Data. Northeast Fish Sci Cent Ref Doc. 16-08; 145 pp.

Sosebee, K. 2018. 2017 NE Skate Stock Status Update. Memo to Greater Atlantic Regional Fisheries Office; -15 pp.

	BARNDOR	CLEARNOSE	LITTLE	ROSETTE	SMOOTH	THORNY	WINTER
Survey (kg/tow)	Autumn	Autumn	Spring	Autumn	Autumn	Autumn	Autumn
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 2,5,8,11,14,17,20,23,2 6,29,32,35,38,41,44- 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
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	1.54 <sup>c</sup>	<sup>c</sup>	6.09	<sup>c</sup>	0.34 <sup>c</sup>	0.21 <sup>c</sup>	8.40 <sup>c</sup>
2018	2.80 <sup>e</sup>	0.88	4.41	0.051	0.25 <sup>e</sup>	0.14 <sup>e</sup>	6.41 <sup>e</sup>
2019	1.71	1.23	5.45	0.050	0.24	0.18	11.00
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>a,b</sup>	0.047	0.23	0.176	6.65
2015-2017 3-year average	1.57 <sup>c</sup>	<sup>c</sup>	5.49 <sup>b</sup>	<sup>c</sup>	0.27 <sup>c</sup>	0.18 <sup>c</sup>	7.13 <sup>c</sup>
2016-2018 3-year average	1.81 <sup>c,e</sup>	0.61 <sup>d</sup>	4.69 <sup>b</sup>	.047 <sup>d</sup>	0.27 <sup>c,e</sup>	0.16 <sup>c,e</sup>	7.22 <sup>c,e</sup>
2017-2019 3-year average	2.02 <sup>c,e</sup>	1.05 <sup>d</sup>	5.32	0.050 <sup>d</sup>	0.27 <sup>c,e</sup>	0.18 <sup>c,e</sup>	8.61 <sup>c,e</sup>
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	+13.2	+3.7	+24.2
Percent change 2015-2017 compared to 2014-2016	-0.1.5		-2.6		+16.3	-0.6	+7.3
Percent change 2016-2018 compared to 2015-2017	+15.3	+3.1 <sup>d</sup>	-14.6	+0.1 <sup>d</sup>	-0.2	-8.4	+1.2
Percent change 2017-2019 compared to 2016-2018	+11.4	+73.1	+13.4	+6.4	+1.7	+11.4	+19.2
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

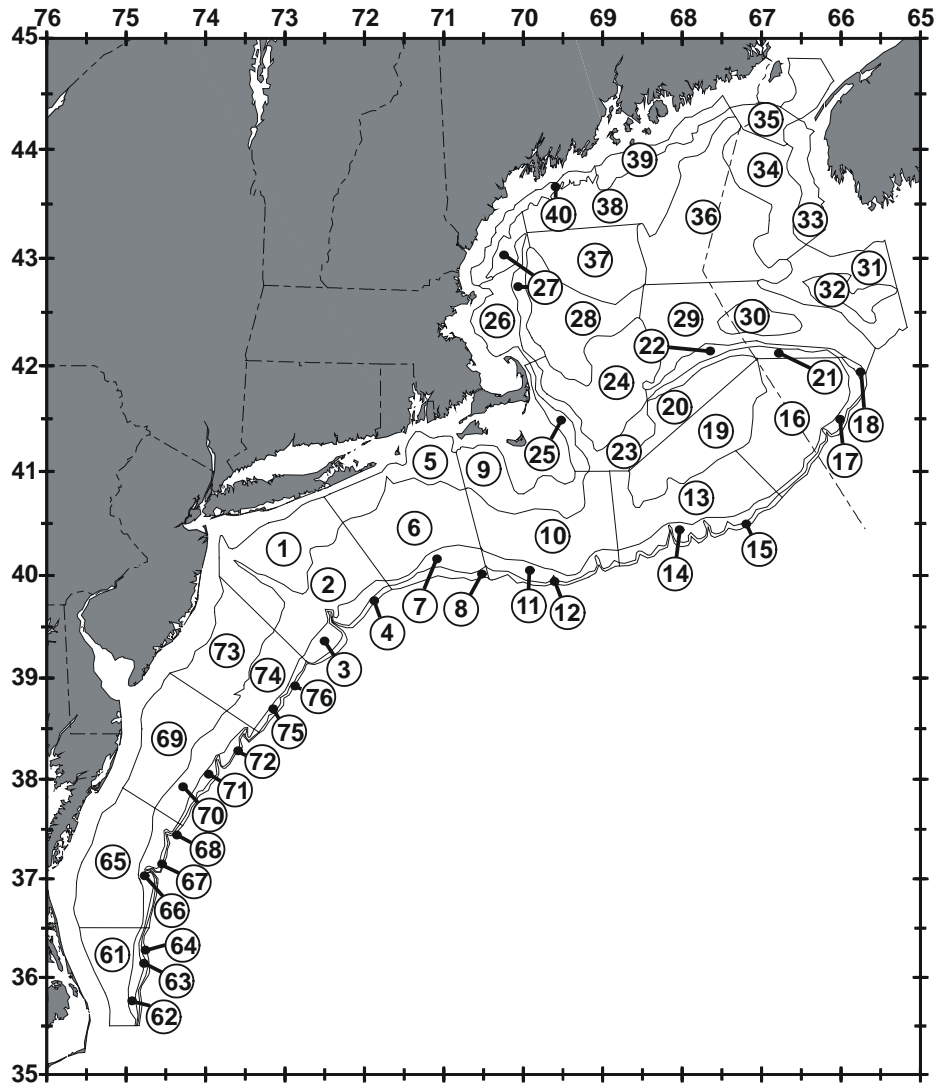
**Table 1.** a. No survey tows completed south of Delaware in spring 2014. Values for 2014 were adjusted for missing strata (Offshore 61-68, Inshore 32, 35, 38, 41, 44) but may not be fully comparable to other surveys which sampled all strata. b. The 2016 spring survey was later than usual. c. No survey tows completed south of Georges Bank in fall 2017. Values either missing or were adjusted for missing strata (Offshore 1-12, 61-76). d. Two-year average due to missing 2017 survey. e. Values were adjusted for missing Offshore strata 30, 34 and 35.

# Skate Complex Biomass Indices

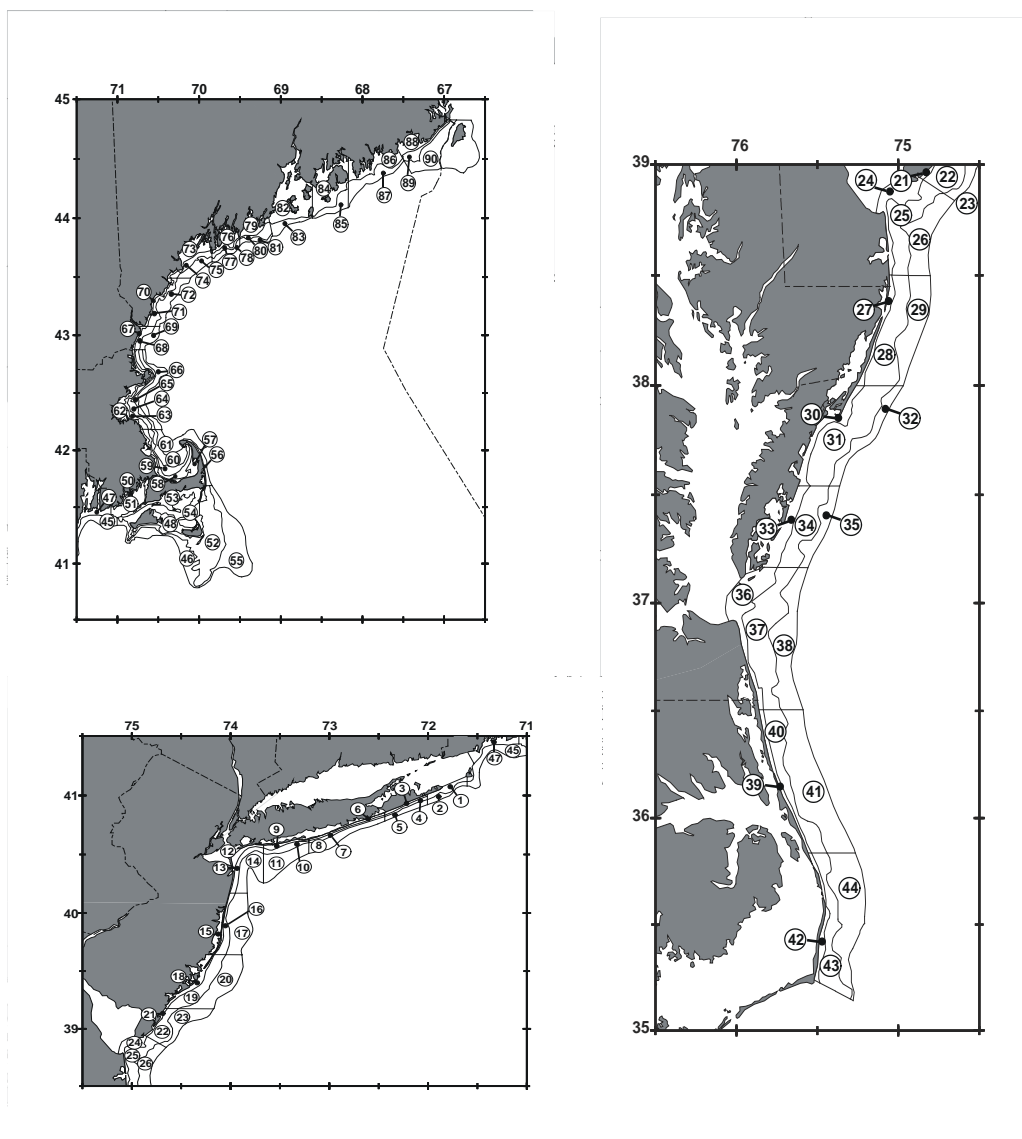


Figure

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.

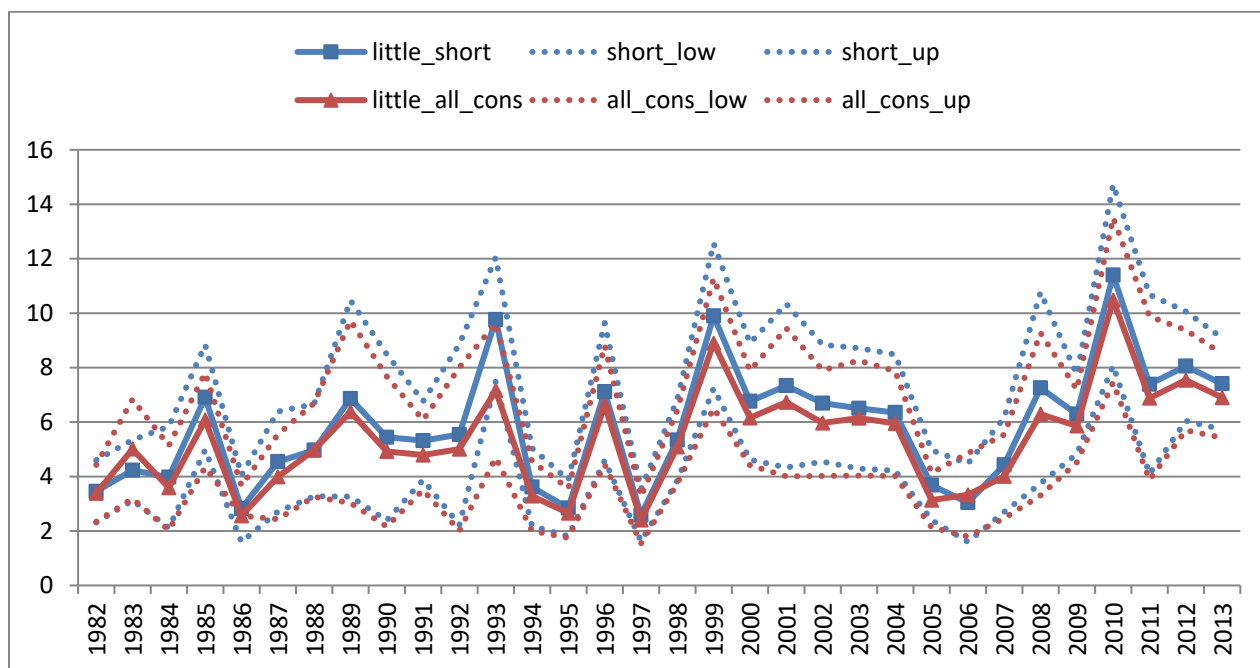


**Figure 2.** Offshore strata from the NEFSC spring and fall surveys.

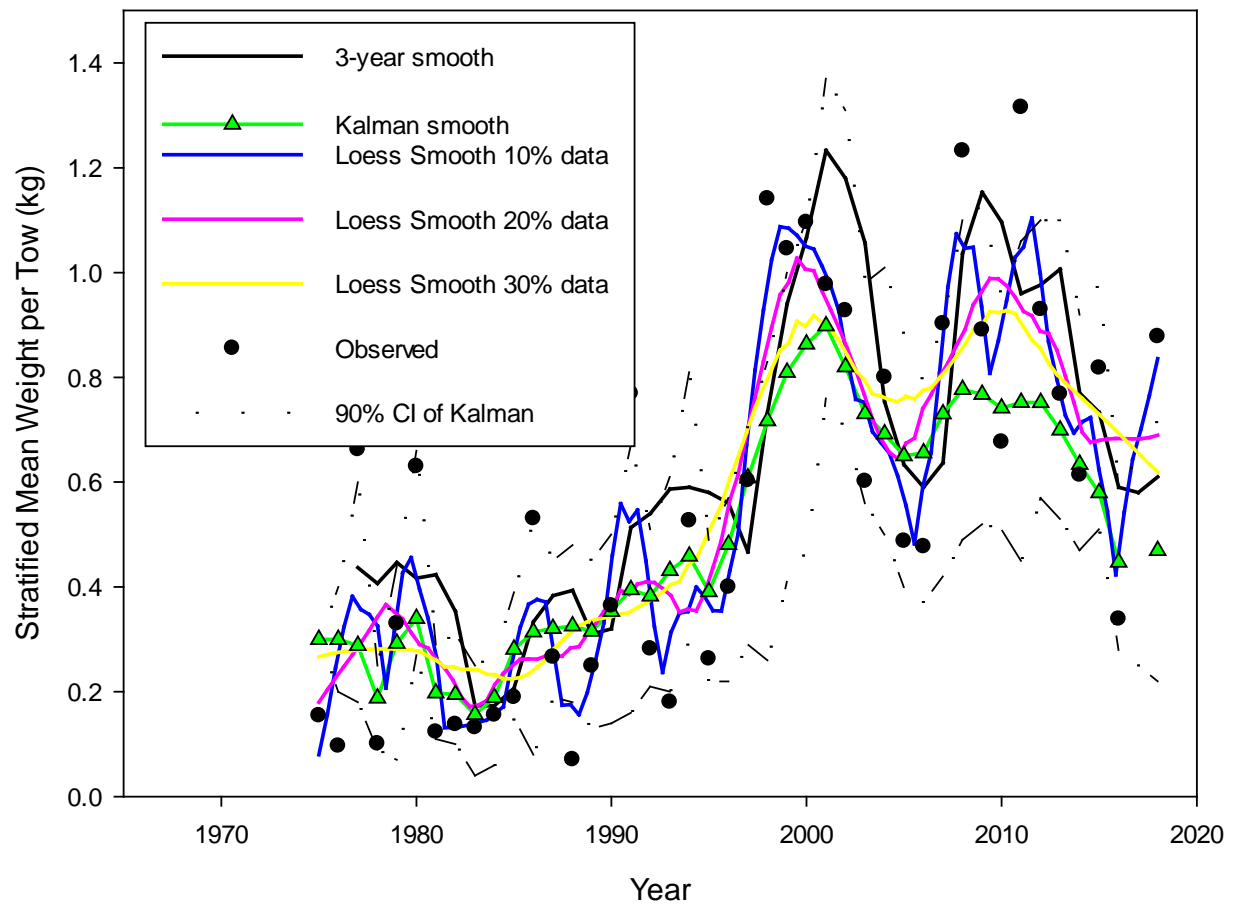


**Figure 3.** Inshore strata from the NEFSC spring and fall surveys.

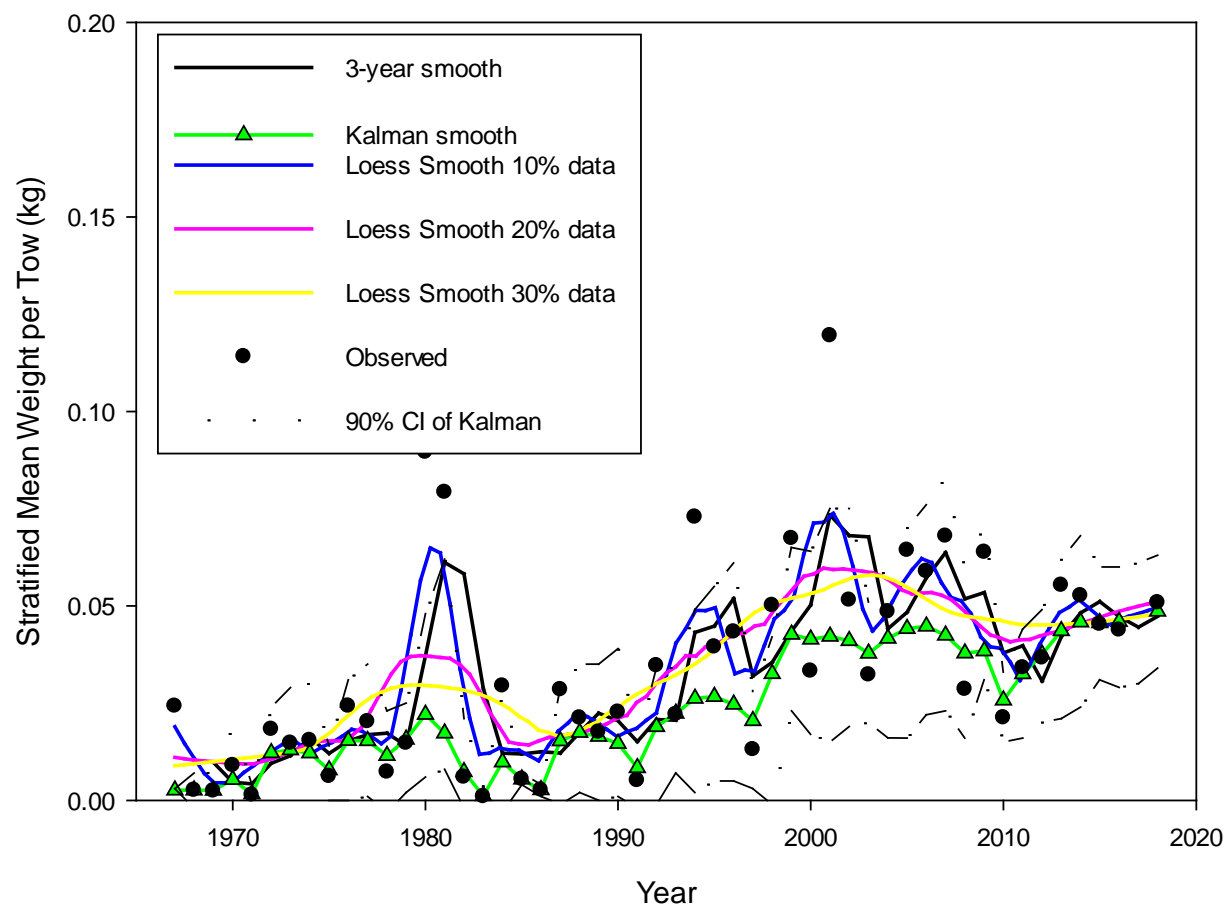




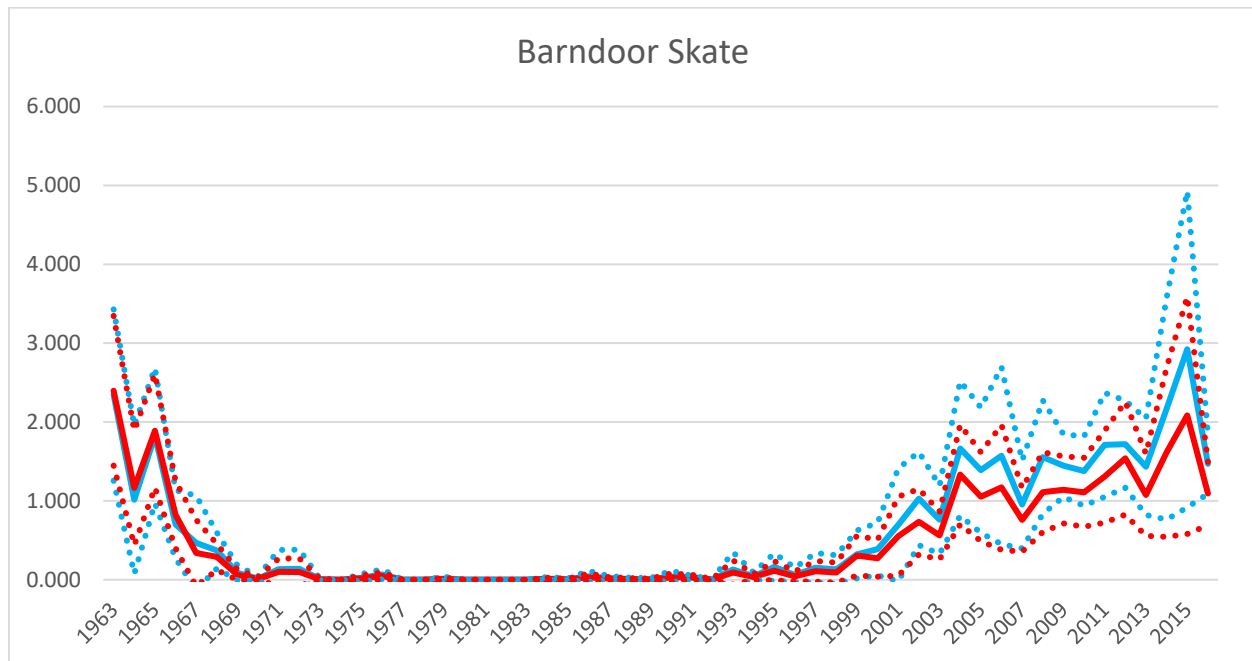
**Figure 4.** Little skate spring indices (kg/tow) based on all strata (i.e., full strata set; red triangles) and based on truncated strata set (i.e., strata south of Delaware Bay were removed; blue squares) from 1982-2013. The 95% confidence limits for each series are shown as dotted lines in the same 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).



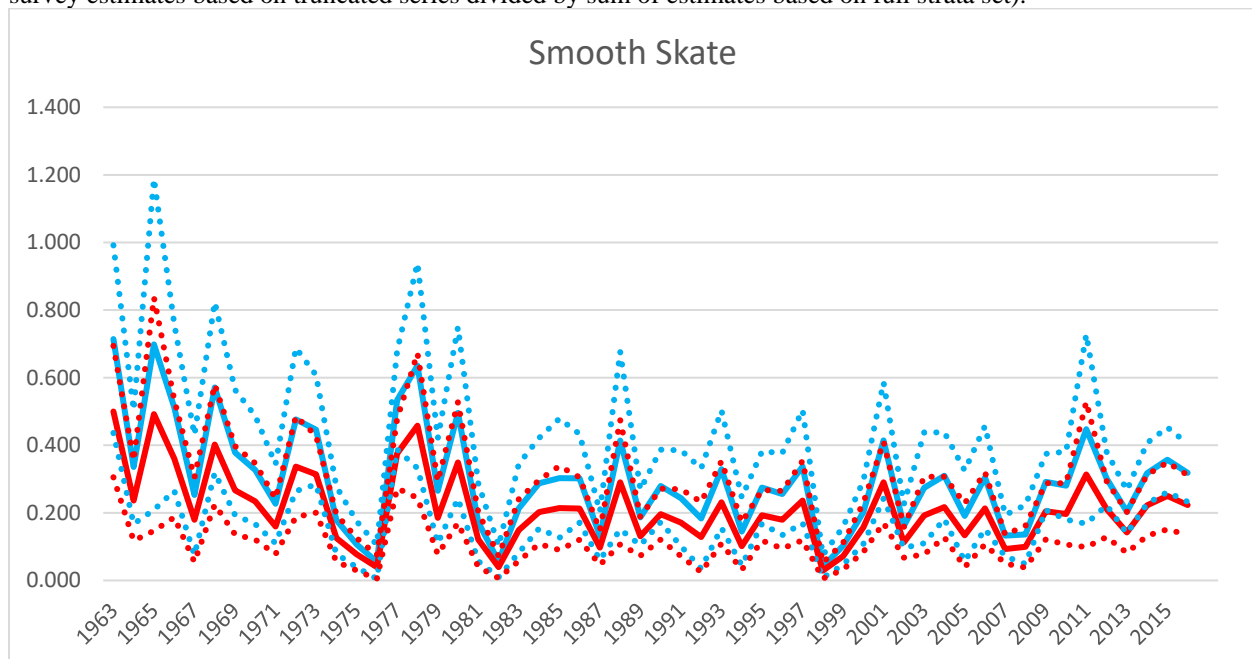
**Figure 5.** Comparison of smoothers for clearnose skate.



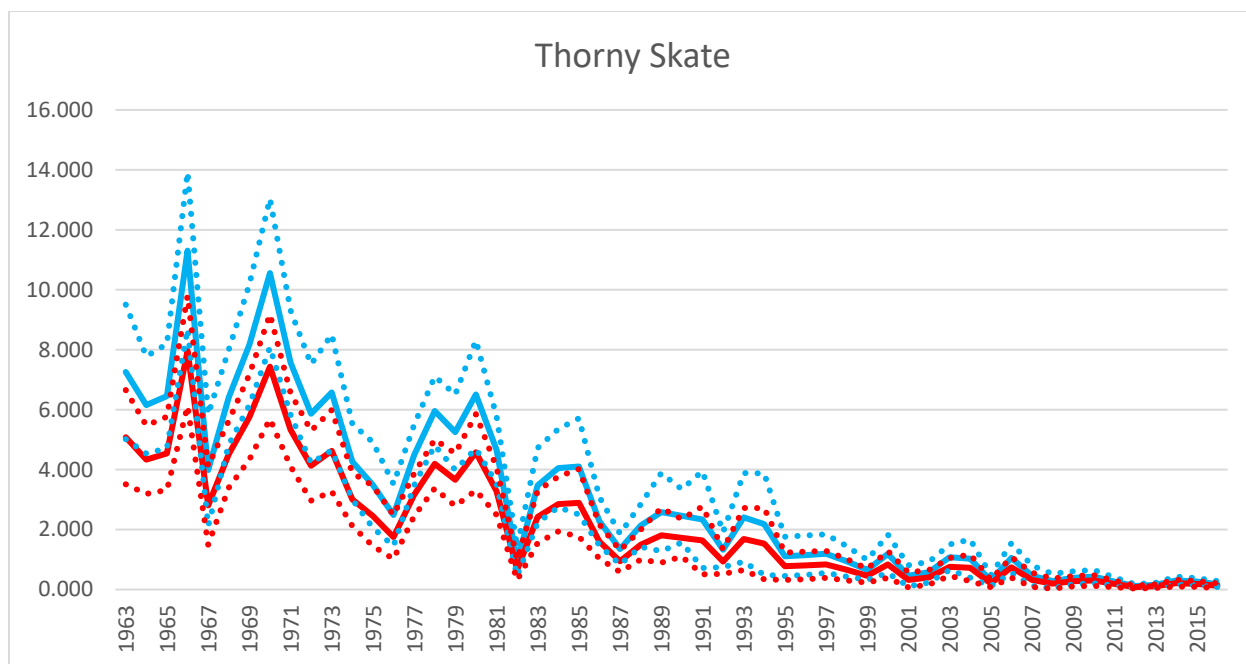
**Figure 6.** Comparison of smoothers for rosette skate.



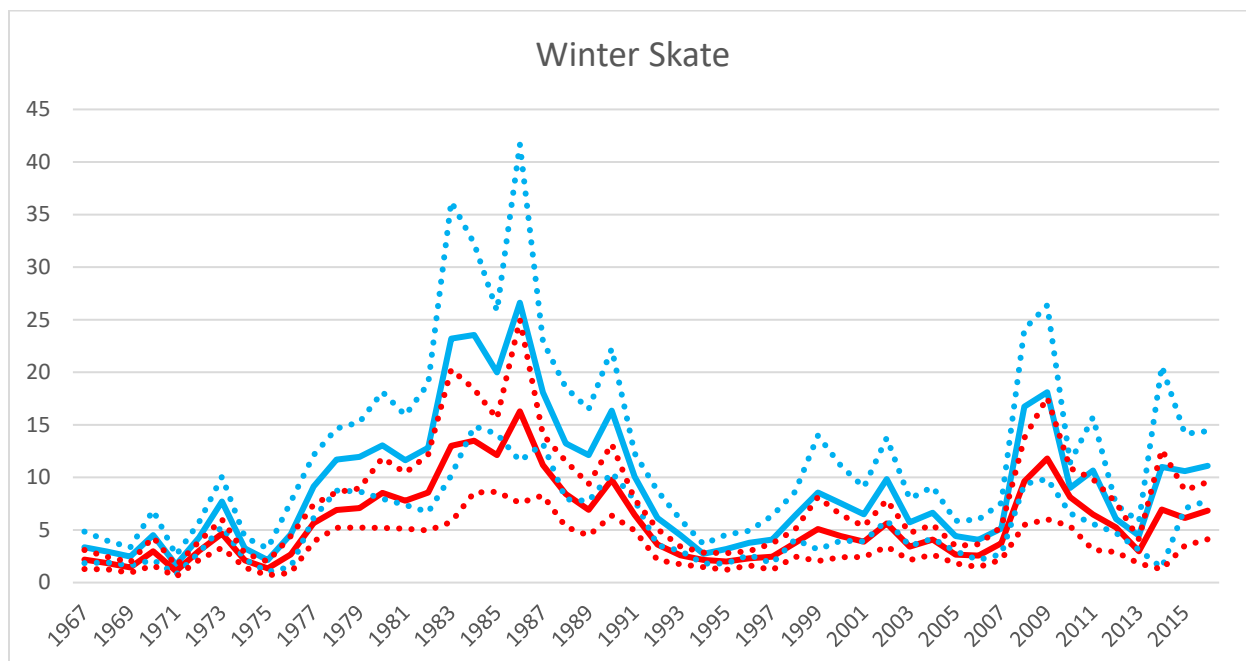
**Figure 7.** Barndoor skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.222 (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).



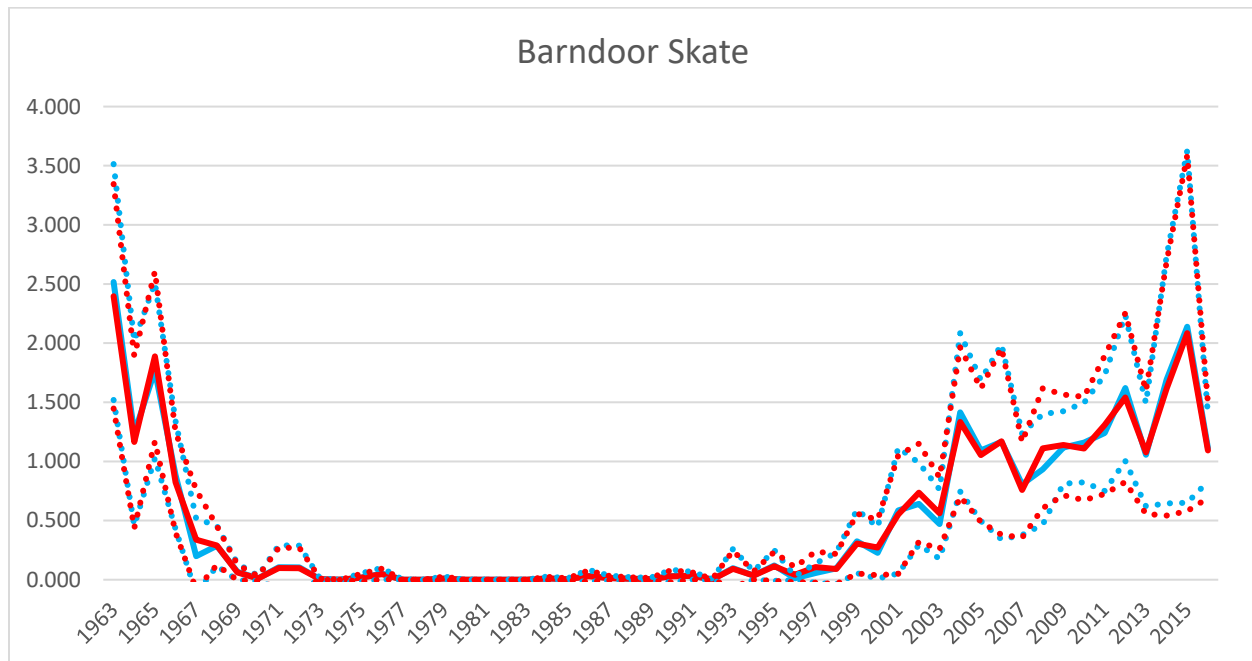
**Figure 8.** Smooth skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.418 (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).



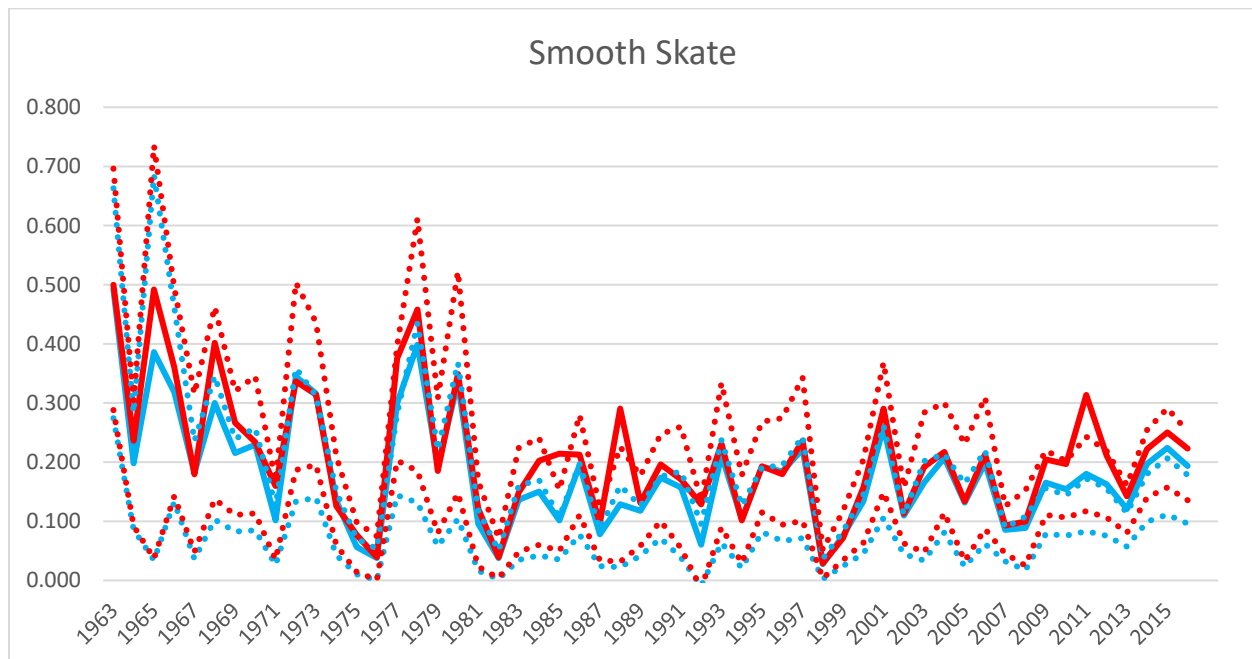
**Figure 9.** Thorny skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.423 (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).



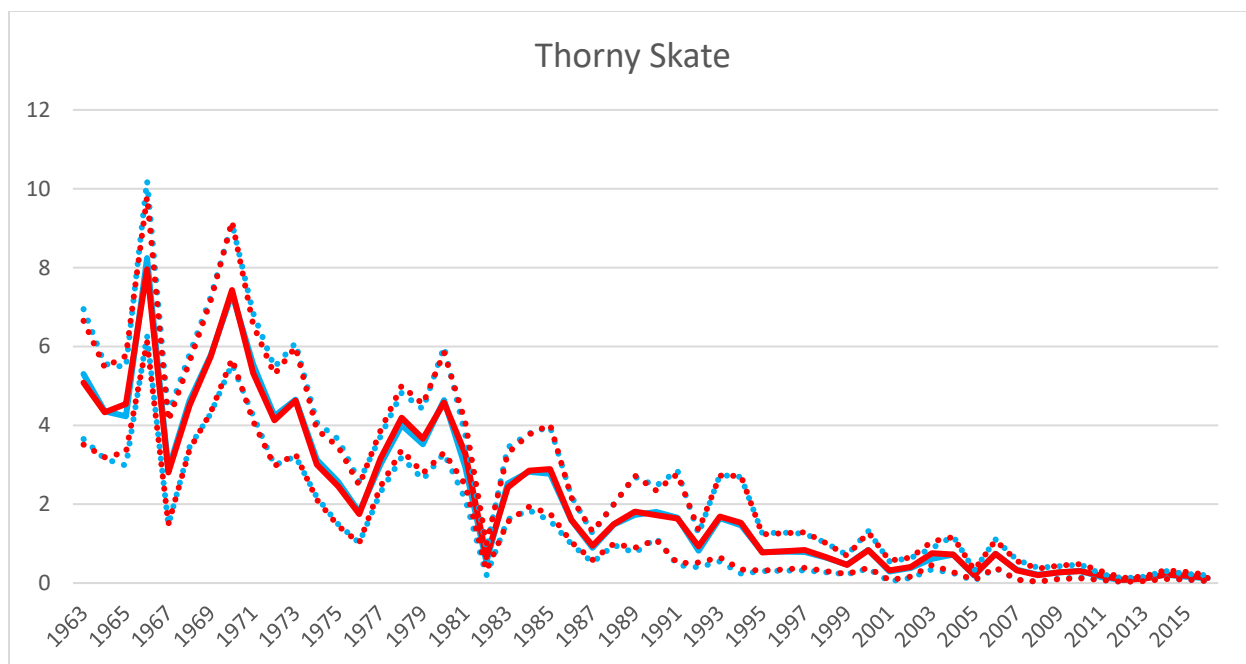
**Figure 10.** Winter skate autumn indices (kg/tow) based on all offshore strata (full strata set; red) and based on truncated strata set (strata south of Georges Bank were removed; blue) from 1967-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 1.610 (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).



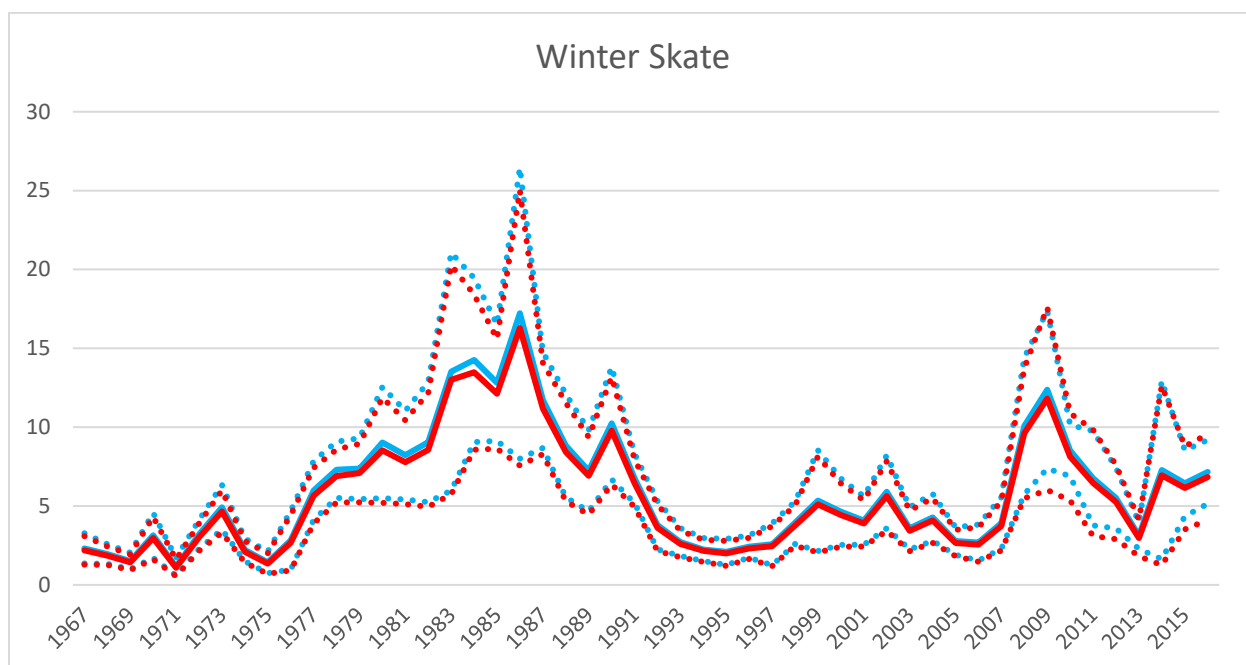
**Figure 11.** Barndoor skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (offshore strata 01300, 01340, and 01351 were removed; blue) from 1963-2016. The 95% confidence limits for each series are shown as dotted lines in the same color. The survey catch ratio of the truncated strata set to the full strata set is 0.998 (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 12.** Smooth skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (offshore strata 01300, 01340, and 01351 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 0.860 (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 13.** Thorny skate autumn indices (kg/tow) based on offshore strata from Gulf of Maine to Southern New England (full strata set; red) and based on truncated strata set (offshore strata 01300, 01340, and 01351 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 0.996 (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 14.** Winter skate autumn indices (kg/tow) based on all offshore strata (full strata set; red) and based on truncated strata set (offshore strata 01300, 01340, and 01351 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 1.051 (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).