Figure 33 Abundance and Biomass of Clearnose Skate from the NEFSC Autumn Bottom Trawl Survey in the Gulf of Maine to Mid-Atlantic Region, Offshore and Inshore Regions

Mean Index in Solid Squares, 95% Confidence Interval in Open Squares

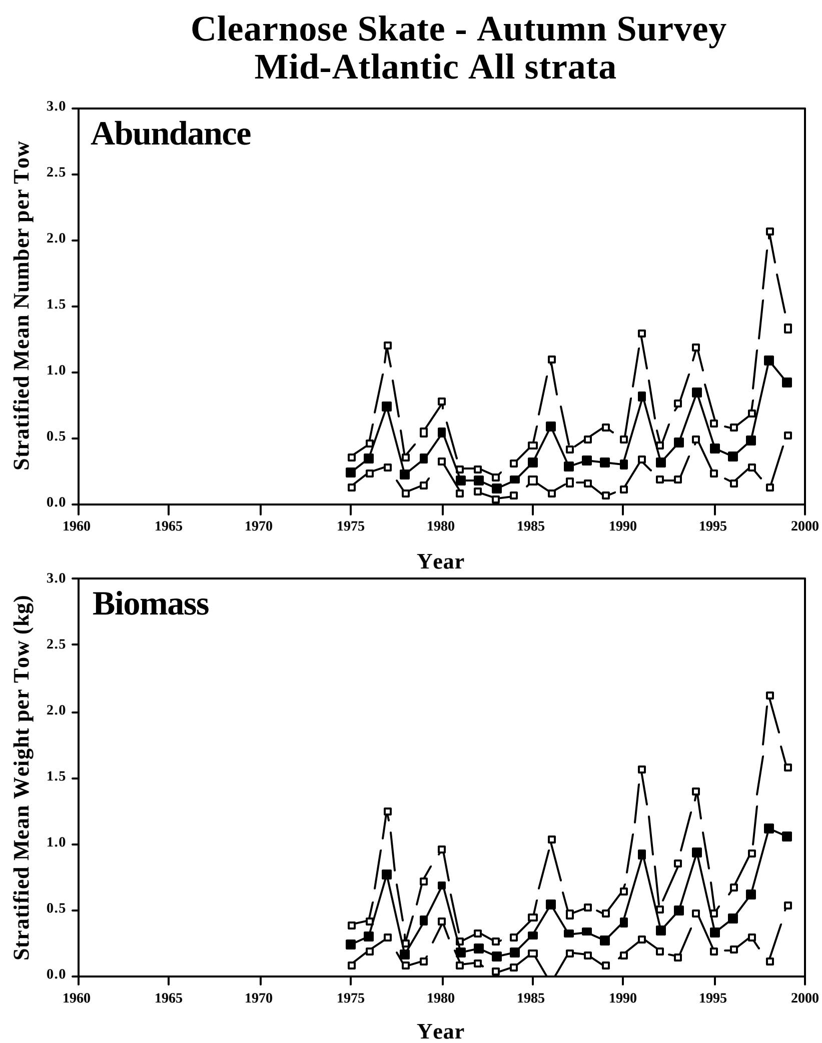


Figure 34 Percentiles of Length Composition (5, 50, and 95) of Clearnose Skate from the NEFSC Spring and Autumn Bottom Trawl Surveys from 1975-2000 in the Mid-Atlantic Offshore and Inshore Regions

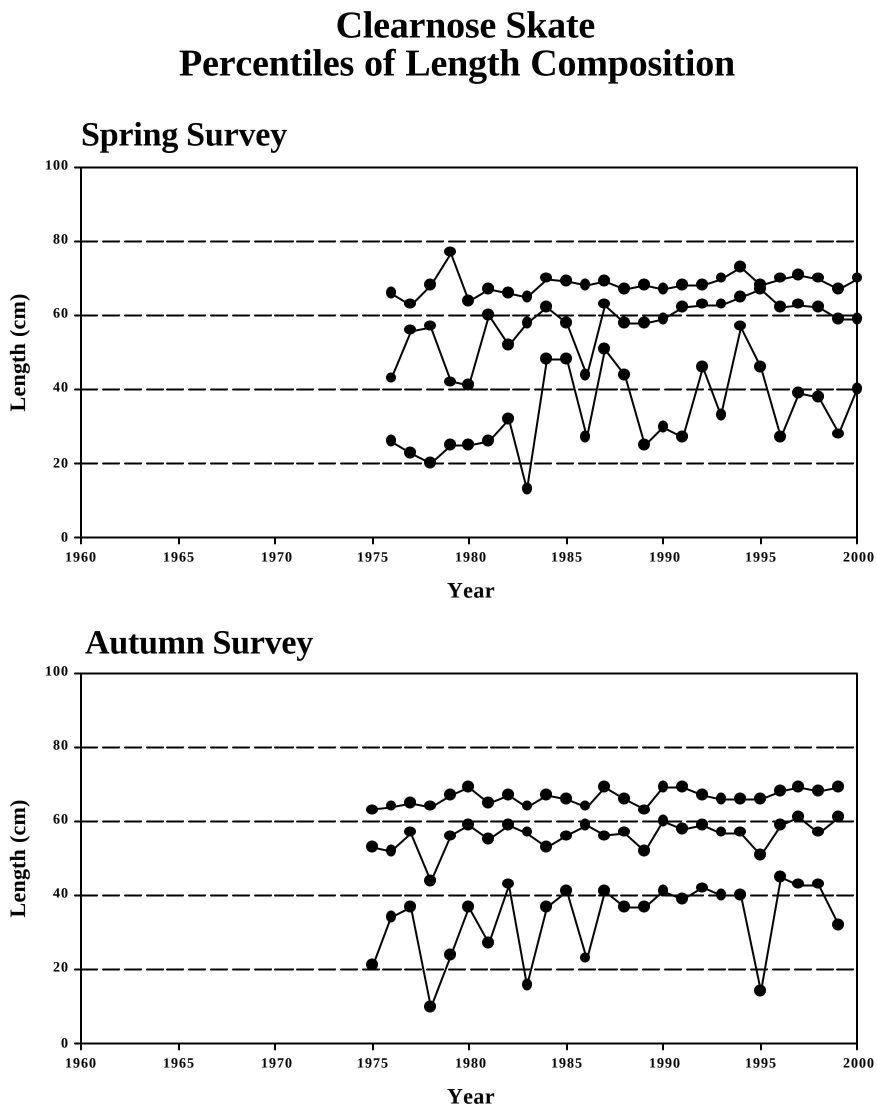


Figure 35 Abundance and Biomass of Clearnose Skate from the CTDEP Spring and Autumn Finfish Bottom Trawl Survey in Connecticut State Waters

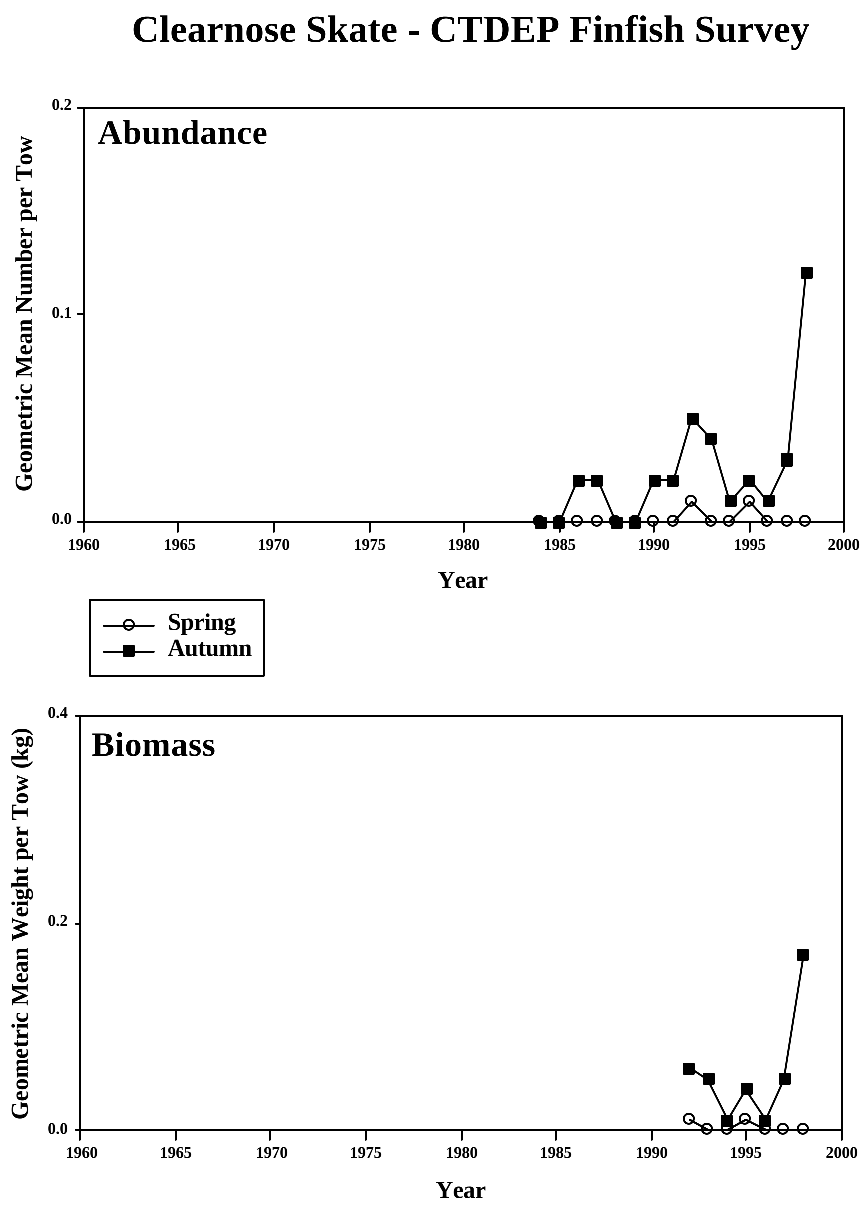
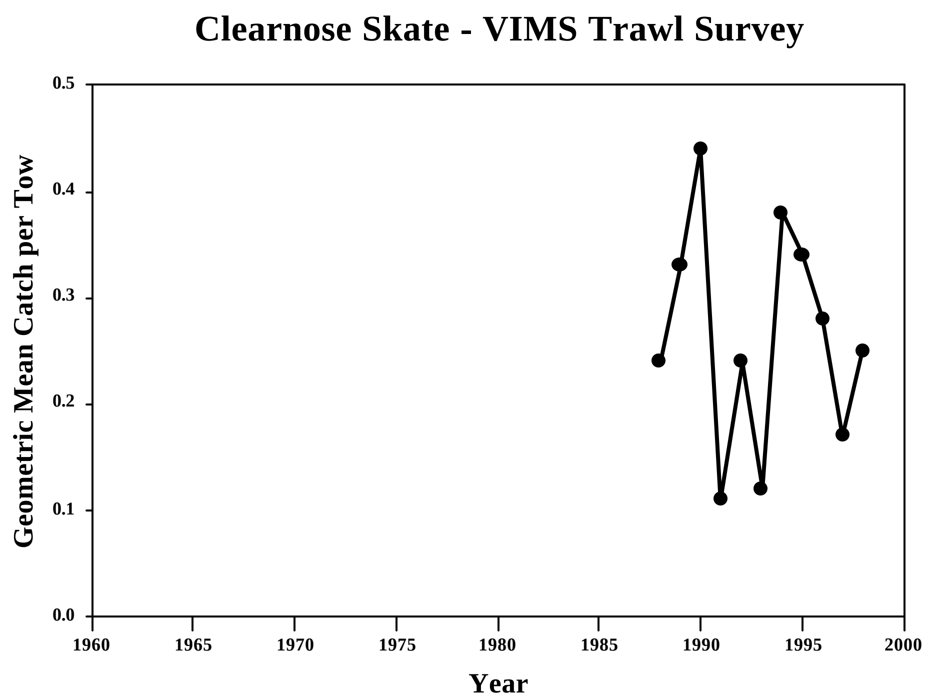


Figure 36 Abundance of Clearnose Skate from the VIMS Trawl Survey, 1988-1998



2.3.1.7 Rosette Skate

NEFSC bottom trawl surveys indicate that rosette skate are most abundant in the Mid-Atlantic offshore strata region, with very few fish caught in Southern New England and no fish caught in other survey regions (**Appendix I**). In the NEFSC spring surveys (1968-2000), the annual total catch of rosette skate has ranged from 0 fish in 1984 to 70 fish in 1977. In the NEFSC autumn surveys (1963-1999), the annual total catch of rosette skate has ranged from 1 fish, most recently in 1982, to 45 fish in 1981. Calculated on a per tow basis, these spring survey catches equate to maximum stratified mean number per tow indices for the Mid-Atlantic offshore strata set of about 0.6 fish, or about 0.1 kg, per tow during 1977 (Table 18 and Table 19).

The catchability of rosette skate in the recently instituted NEFSC winter bottom trawl survey (which substitutes a chain sweep with small cookies for the large rollers used in the spring and autumn surveys, to better target flatfish) is significantly higher than in the spring and autumn series. NEFSC winter survey (1992-1999) annual catches of rosette skate have ranged from 143 fish in 1993 to 899 fish in 1996, equating to a maximum stratified mean catch per tow of 1.4 fish or 0.3 kg per tow in 1996 (Table 20). The winter survey is focused in the Southern New England and Mid-Atlantic offshore regions, with a limited number of samples on Georges Bank, and no sampling in the Gulf of Maine.

Indices of rosette skate abundance and biomass from the NEFSC surveys were at a peak during 1975-1980, before declining through 1986. NEFSC survey indices for rosette skate have been increasing since 1986, and recent indices are at about 50% of the peak values of the late 1970s (Figure 37 – Figure 39).

The minimum length of rosette skate caught in NEFSC surveys is about 7 cm (3 in), and the largest individual caught was 57 cm (22 in) total length, during the 1971 spring survey in the Mid-Atlantic Bight region. The median length of the survey catch has ranged from 18 cm in the 1985 spring survey to 57 cm in the 1971 spring survey, during which only one rosette skate was caught. The median length of the survey catch has been stable over the spring and autumn time series at about 36-37 cm (14 in; Figure 40). Length frequency distributions from the NEFSC spring and autumn surveys are presented in the SAW 30 documents as Figures B103 – B106 and are not reproduced in this SAFE Report. In general, the length frequency distributions show a consistent mode at 30-40 cm.

Table 18 Abundance and Biomass from NEFSC Spring Surveys for Rosette Skate for the Mid-Atlantic Region

The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 1968-2000.

	weight/tow			number/tow				length						nonzero	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
1968	0.005	-0.002	0.012	0.014	0.000	0.029	0.356	33	33	33	34.4	35	36	3	3
1969	0.001	-0.001	0.002	0.003	-0.003	0.010	0.200	37	37	37	37.0	37	37	1	1
1970	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	0	0
1971	0.005	-0.005	0.014	0.010	-0.009	0.028	0.500	57	57	57	57.0	57	57	1	1
1972	0.000	0.000	0.001	0.003	-0.003	0.010	0.100	35	35	35	35.0	35	35	1	1
1973	0.006	-0.001	0.012	0.023	-0.006	0.052	0.240	38	38	38	38.6	41	42	4	5
1974	0.005	-0.005	0.015	0.025	-0.024	0.074	0.200	41	41	41	41.0	41	41	1	1
1975	0.001	-0.001	0.003	0.005	-0.005	0.014	0.200	38	38	38	38.5	39	39	1	2
1976	0.007	0.000	0.015	0.035	-0.003	0.073	0.208	31	31	36	36.9	44	45	4	6
1977	0.102	0.019	0.186	0.552	0.107	0.998	0.185	20	26	32	33.6	37	42	11	70
1978	0.010	0.001	0.019	0.041	0.008	0.074	0.232	12	25	35	35.3	40	41	7	10
1979	0.007	0.005	0.009	0.040	0.031	0.048	0.171	13	13	34	31.6	40	41	4	10
1980	0.072	0.030	0.115	0.373	0.167	0.580	0.194	26	27	34	35.3	41	42	15	47
1981	0.013	0.001	0.025	0.057	0.006	0.109	0.231	19	28	37	36.3	41	42	6	17
1982	0.025	0.010	0.040	0.108	0.043	0.174	0.234	22	25	37	37.4	43	44	11	20
1983	0.002	-0.001	0.004	0.012	-0.006	0.029	0.147	29	29	34	34.2	35	36	2	5
1984	0.000	0.000	0.000	0.000	0.000	0.000	-	-	-	-	-	-	-	0	0
1985	0.005	-0.001	0.011	0.059	0.040	0.079	0.080	17	17	18	21.0	29	42	3	9
1986	0.002	-0.002	0.006	0.012	-0.008	0.031	0.182	32	32	35	35.3	35	36	2	2
1987	0.003	-0.002	0.009	0.017	-0.012	0.046	0.200	35	35	36	36.7	36	37	2	2
1988	0.020	-0.001	0.041	0.111	-0.002	0.223	0.180	26	26	35	32.8	35	36	4	6
1989	0.010	-0.004	0.025	0.051	-0.036	0.137	0.200	28	28	34	34.6	40	41	2	15
1990	0.010	-0.004	0.024	0.049	-0.022	0.121	0.200	36	36	35	36.0	35	36	3	3
1991	0.036	0.014	0.058	0.143	0.057	0.228	0.253	19	33	37	37.2	40	42	7	19
1992	0.014	-0.001	0.029	0.063	0.012	0.113	0.223	24	24	37	36.0	40	41	5	5
1993	0.009	0.007	0.011	0.037	0.030	0.043	0.255	38	38	37	38.6	39	40	2	5
1994	0.005	0.001	0.009	0.021	0.006	0.035	0.243	36	36	38	38.7	40	41	4	4
1995	0.010	0.000	0.020	0.056	0.003	0.110	0.173	19	19	35	32.9	36	37	3	5
1996	0.014	-0.011	0.039	0.095	-0.013	0.203	0.149	9	9	35	29.3	42	43	5	19
1997	0.028	0.022	0.033	0.138	0.091	0.186	0.200	30	30	34	35.6	41	42	4	25
1998	0.038	0.007	0.068	0.132	0.041	0.223	0.287	32	33	38	38.0	41	42	11	15
1999	0.043	0.003	0.083	0.206	0.012	0.399	0.211	15	29	37	36.7	42	43	9	16
2000	0.026	0.009	0.043	0.106	0.040	0.171	0.247	30	32	37	38.0	41	42	7	15

Table 19 Abundance and Biomass from NEFSC Autumn Surveys for Rosette Skate for the Mid-Atlantic Region

The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 1967-1999.

	weight/tow			number/tow				length						nonzero	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
1967	0.019	0.002	0.037	0.117	0.010	0.224	0.166	10	18	34	34.3	39	42	7	17
1968	0.003	-0.001	0.008	0.023	-0.019	0.065	0.135	28	28	28	28.9	37	38	2	2
1969	0.002	-0.002	0.006	0.010	-0.009	0.028	0.200	38	38	38	38.0	38	38	1	1
1970	0.009	-0.006	0.024	0.033	-0.025	0.090	0.276	39	39	39	39.5	39	40	2	3
1971	0.001	-0.001	0.004	0.006	-0.005	0.016	0.250	40	40	40	40.5	40	41	1	2
1972	0.016	0.001	0.032	0.058	0.021	0.094	0.285	12	12	34	34.2	40	41	7	8
1973	0.012	-0.008	0.032	0.053	-0.016	0.122	0.224	16	16	28	29.0	40	41	3	5
1974	0.012	-0.002	0.026	0.079	-0.014	0.171	0.156	23	23	34	33.8	40	41	4	11
1975	0.004	-0.001	0.009	0.034	-0.001	0.070	0.122	25	25	34	33.6	38	39	4	8
1976	0.024	0.003	0.045	0.149	0.016	0.281	0.163	28	28	33	33.7	37	40	7	21
1977	0.020	-0.002	0.043	0.087	-0.011	0.185	0.231	31	31	33	35.2	40	41	5	8
1978	0.007	-0.007	0.022	0.015	-0.014	0.043	0.500	39	39	39	39.0	39	39	1	1
1979	0.010	-0.004	0.025	0.043	-0.016	0.101	0.242	22	22	35	36.1	39	40	3	6
1980	0.090	0.042	0.138	0.312	0.120	0.505	0.287	14	25	38	36.6	41	42	10	24
1981	0.079	0.011	0.148	0.296	0.052	0.539	0.268	27	28	37	37.5	41	43	10	45
1982	0.006	-0.006	0.018	0.020	-0.019	0.059	0.300	39	39	39	39.0	39	39	1	1
1983	0.001	-0.001	0.003	0.010	-0.010	0.030	0.100	12	12	12	20.7	36	37	1	3
1984	0.029	0.005	0.053	0.128	0.033	0.223	0.229	13	26	36	35.6	39	40	7	16
1985	0.005	0.004	0.007	0.036	0.019	0.054	0.146	14	14	25	28.0	35	36	5	6
1986	0.003	0.001	0.004	0.009	0.005	0.013	0.300	37	37	37	38.2	39	40	3	3
1987	0.028	0.006	0.050	0.112	0.040	0.183	0.253	11	15	38	32.7	41	42	7	10
1988	0.021	0.000	0.043	0.093	-0.002	0.188	0.228	30	30	32	35.0	41	42	5	8
1989	0.018	-0.005	0.041	0.046	-0.012	0.105	0.378	33	33	33	33.5	36	37	3	4
1990	0.023	-0.004	0.049	0.099	0.001	0.198	0.228	32	32	37	37.7	41	42	5	10
1991	0.005	-0.004	0.014	0.021	-0.009	0.051	0.237	15	15	34	31.4	34	35	3	3
1992	0.035	0.006	0.064	0.170	0.033	0.308	0.203	25	25	35	35.3	41	42	9	11
1993	0.021	0.005	0.037	0.102	0.033	0.170	0.211	25	25	37	35.1	40	41	4	8
1994	0.073	0.000	0.146	0.301	0.006	0.597	0.242	27	27	37	36.8	42	43	6	21
1995	0.039	-0.005	0.084	0.174	-0.009	0.358	0.227	19	24	35	35.1	38	39	7	13
1996	0.043	-0.014	0.100	0.273	-0.127	0.674	0.158	7	19	32	31.6	38	42	7	21
1997	0.013	0.000	0.026	0.074	-0.014	0.162	0.176	31	31	33	34.0	42	43	4	6
1998	0.050	-0.008	0.108	0.208	-0.042	0.458	0.241	33	33	37	38.1	40	41	7	22
1999	0.067	0.038	0.096	0.380	0.182	0.578	0.177	12	18	34	32.6	41	42	8	46

Table 20 Abundance and Biomass from NEFSC Winter Surveys for Rosette Skate for the Georges Bank to Mid-Atlantic Region

The mean index, 95% confidence intervals, individual fish weight, minimum, mean, and maximum length, 5th, 50th, and 95th percentiles of length, number of nonzero tows, and number of fish caught are presented for 1992-1999.

	weight/tow			number/tow				length						nonzero	
	mean	lower	upper	mean	lower	upper	ind wt	min	5%	50%	mean	95%	max	tows	no fish
1992	0.264	0.138	0.390	1.125	0.619	1.632	0.235	16	27	36	36.4	41	45	15	230
1993	0.149	0.048	0.251	0.663	0.197	1.130	0.225	26	29	36	36.7	39	41	9	143
1994	0.199	0.148	0.249	0.761	0.608	0.914	0.261	16	28	37	36.8	40	44	15	162
1995	0.195	0.066	0.323	0.774	0.273	1.275	0.252	19	32	37	37.9	41	42	23	197
1996	0.324	0.121	0.526	1.410	0.443	2.376	0.230	19	28	36	36.3	40	46	23	899
1997	0.258	-0.051	0.567	1.079	-0.194	2.353	0.239	13	30	36	36.9	40	44	21	238
1998	0.160	0.102	0.219	0.664	0.421	0.907	0.241	15	30	36	36.5	40	45	21	350
1999	0.271	0.043	0.500	1.151	0.082	2.220	0.236	24	27	37	36.6	41	44	25	228
2000	0.344	0.198	0.491	1.357	0.725	1.989	0.254	8	28	37	37.5	43	47	34	740

Figure 37 Abundance and Biomass of Rosette Skate from the NEFSC Spring (Circles) and Autumn (Squares) Bottom Trawl Surveys from 1963-2000 in the Mid-Atlantic Offshore Region

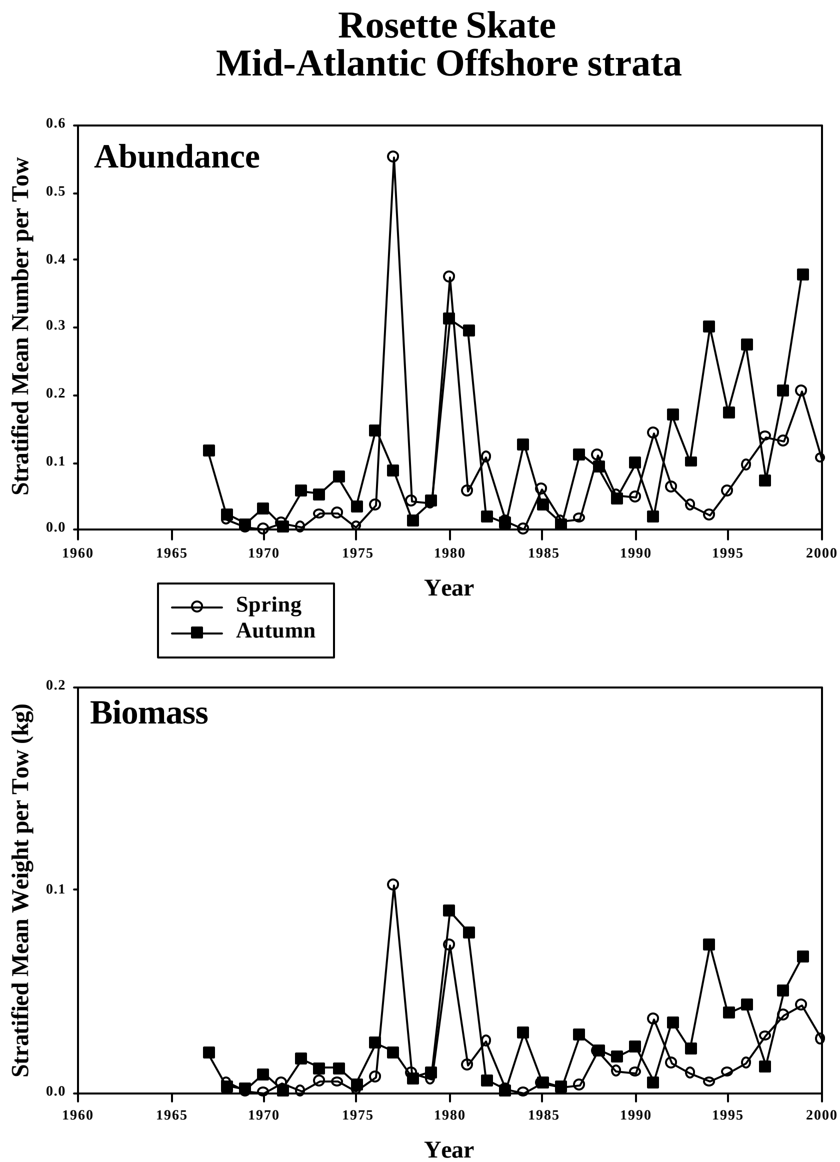


Figure 38 Abundance and Biomass of Rosette Skate from the NEFSC Spring Bottom Trawl Survey in the Mid-Atlantic Region, Offshore Strata Only

Mean Index in Solid Squares, 95% Confidence Interval in Open Squares

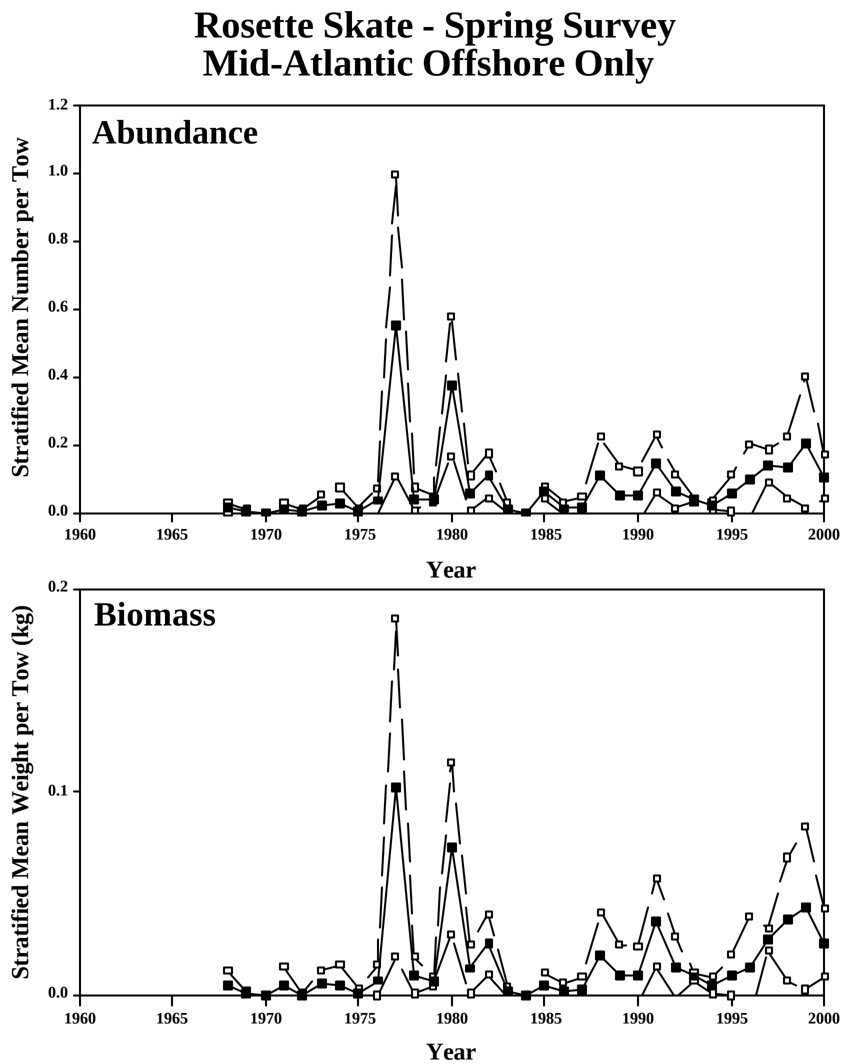


Figure 39 Abundance and Biomass of Rosette Skate from the NEFSC Autumn Bottom Trawl Survey in the Mid-Atlantic Region, Offshore Strata Only

Mean Index in Solid Squares, 95% Confidence Interval in Open Squares

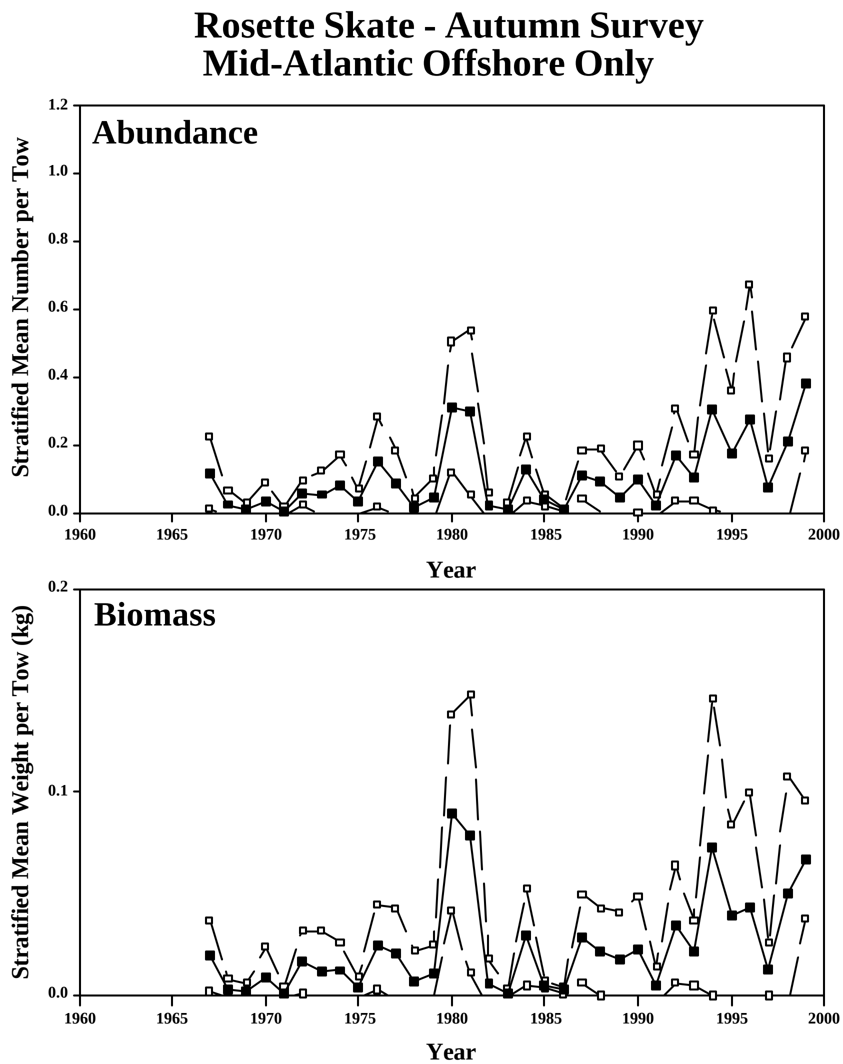
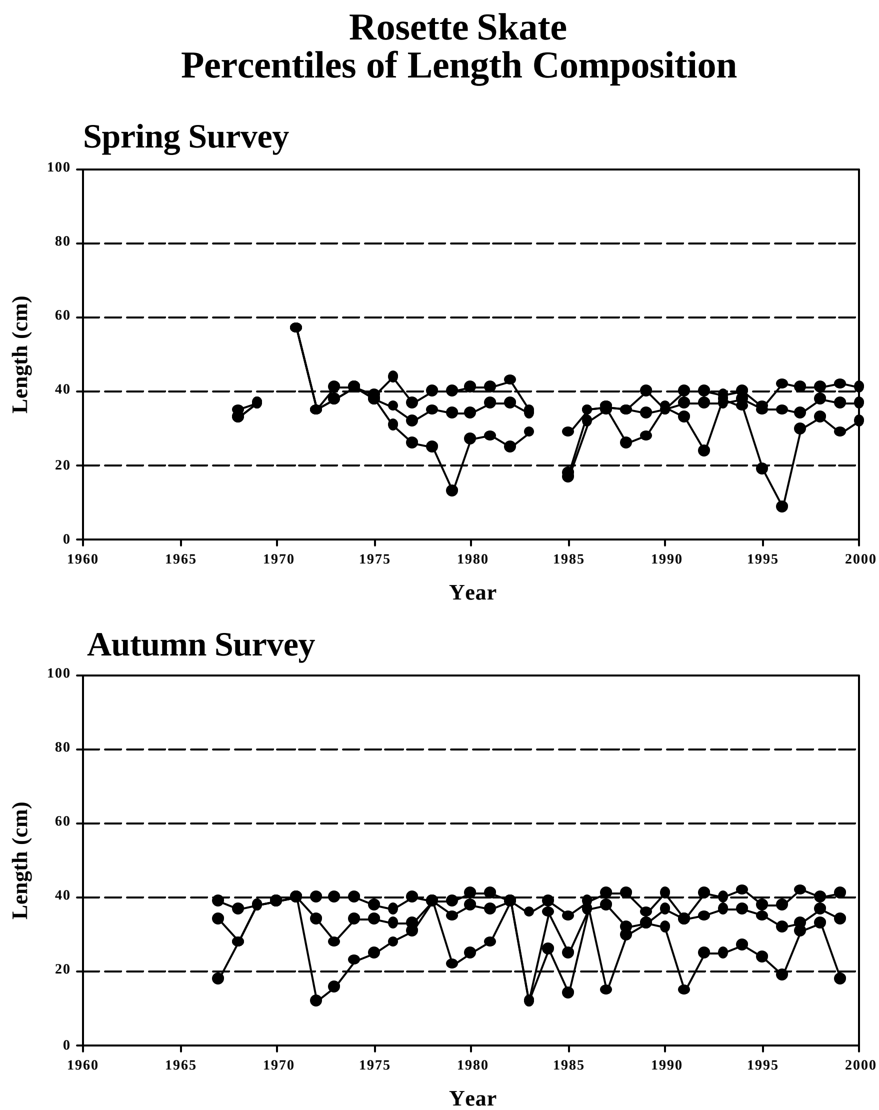


Figure 40 Percentiles of Length Composition (5, 50, and 95) of Rosette Skate from the NEFSC Spring and Autumn Bottom Trawl Surveys from 1967-2000 Mid-Atlantic Offshore Region



2.3.2 Biological Data and Reference Points

Increases in the northeast region's skate landings since 1980 and the potential for rapidly expanding export markets bring into question the level at which sustainable fisheries for these species can be maintained (Holden 1973). Skates have a limited reproductive capacity, and stock size could be quickly reduced through intensive exploitation. In some areas of the world where skates have been the targets of directed fisheries, their numbers have been reduced to extremely low levels (*e.g.*, in the Irish Sea; Brander 1981).

Frisk (MS 1999) compiled a summary of available life history parameters for skate species from around the world and developed predictive relationships between total length (L_{max}) and length of maturity (L_{mat}) and age of maturity (A_{mat}). Frisk concluded that the ratio of instantaneous natural mortality to the von Bertalanffy growth coefficient (M/K ratio) was about 1.0 for elasmobranchs (including skates).

The following subsections describe biological data and biological reference points developed by the SARC at SAW 30 for the seven individual species of skates in the northeast region's complex.

2.3.2.1 Winter Skate

Winter skates are a relatively long-lived, slow growing species. Estimates of age and growth parameters are available for winter skate in Canadian waters (eastern Scotian Shelf) from Simon and Frank (1996), who reported the preliminary results of an age and growth study conducted at St. Mary's University by R. Nearing. Simon and Frank (1996) reported that the study of winter skate from 12 to 100 cm found ages from 0-group to 16 years, providing von Bertalanffy parameters of L_{inf} = 114.1 cm, K = 0.14405, and t_0 = 0.00315. Simon and Frank (1996) used the relationships developed by Taylor (1958) and Hoenig (1983) to estimate a maximum age of 20.8 years and a value of M of 0.214 for winter skate. Simon and Frank (1998) found that winter skate on the eastern Scotian Shelf reached 50% maturity at about 75 cm.

Frisk (MS 1999) references McEachran (In press) as the source for a maximum length (L_{max}) of 150 cm and length of maturity (L_{mat}) of 79.5 cm. Using Frisk's predictive equations and the NEFSC survey maximum observed length of 113 cm provides estimates of L_{mat} of 85 cm and A_{mat} of seven years.

The SARC used recent NEFSC spring and autumn survey cumulative length distributions (1994-1999), and recent landed skate cumulative length distributions from NEFSC sea sampling of the commercial fishery (1994-1999) to develop a contemporary estimate of the retained or landed length (L_{50} = 77 cm) and age of recruitment of winter skate to the commercial fisheries for use in a Thompson and Bell (1936) yield per recruit analysis (YPR). The SARC noted that this retained or landed length reflected the kept portion of the catch recorded in the sea sample data, and was much higher than might be expected given the size of trawl mesh (generally 6 inches or smaller) used in nearly all of the region's trawl fisheries. The SARC concluded that it was more reasonable to assume a length closer to that assumed for little skate (L' = 45 cm) for use in reference point and mortality rate models, and so the NEFSC survey L' = 50 cm was assumed to be more reasonable as the length of recruitment (L_{50}) to the commercial fishery for winter skate.

Growth parameters and proportions mature at age from Simon and Frank (1996, 1998) for winter skate in Canadian waters were used to estimate parameters for the YPR model. The length-weight equation from NEFSC survey data collected during 1991- 1998 was used to convert length to weight. Winter skate are estimated to attain full recruitment to the fisheries at age 3. Frisk's work suggests that the M/K ratio for skates is about 1.0. Taking into consideration the Simon and Frank (1996) estimate of K = 0.14, **the SARC concluded that a value of M = 0.1 and an inferred maximum age of 30 years is appropriate for winter skate, providing estimates of F_{max} = 0.12 and $F_{0.1}$ = 0.08**. Input data and the results of Thompson and Bell (1936) yield and spawning biomass per recruit calculations for winter skate are presented in Table B29 of the SAW 30 documents.

The SARC has concluded that yield per recruit-based reference points for winter skate in the northeast region are unreliable due to the use of growth parameters from Canadian waters and the uncertainty of partial recruitment to the commercial fishery. A threshold fishing mortality reference point is therefore proposed for winter skate based on the estimate of the natural mortality rate (M). **For winter skate, the SARC recommends F = M = 0.10 as a proxy for the SFA threshold fishing mortality reference point. The SARC recommends against using F_{max} as a proxy for $F_{threshold}$ due to life history considerations. The SARC proposes use of the 75th percentile value of the NEFSC autumn biomass indices for the GOM-MA offshore region during 1967-1998 as a proxy for the SFA target biomass reference point for winter skate (6.46 kg/tow), and one-half of that value as the SFA threshold biomass reference point for winter skate (3.23 kg/tow; Figure 41).**

2.3.2.2 Little Skate

Little skates are a relatively short-lived, fast growing species. Frisk (MS 1999) references Johnson (1979) as the source for maximum lengths (L_{max}) of 60 cm (males) and 62 cm (females) cm, A_{max} of 4 years for both sexes, L_{mat} of about 45 cm for both sexes, fecundity of 30 egg cases per year, and maximum age of 8 years. Using Frisk's predictive equations and the NEFSC survey maximum observed length of 62 cm provides estimates of L_{mat} of 50 cm and A_{mat} of 4 years; using Waring's (1984) L_{inf} value of about 53 cm provides an estimate of L_{mat} of 43 cm.

Waring (1984) investigated the age, growth, mortality, and yield per recruit of little skate in the Georges Bank-Delaware Bay region using NEFSC trawl survey data collected during 1968-1978. Waring (1984) observed a maximum age of 8 years, and estimated von Bertalanffy growth parameters of L_{inf} = 52.73 cm, K = 0.352, and t_0 = -0.449 years, based on interpretation of presumed annual rings in the centrum of 923 little skate vertebrae. The length-weight relationship for both sexes combined over the years of the Waring (1984) study was $\log_{10}W_g = -2.641 + 3.229 * \log_{10}L_{cm}$. Waring (1984) assumed an age-2 entry to the trawl fishery of the 1970s in estimating values of F_{max} = 1.00 and $F_{0.1}$ = 0.49, for M = 0.4, but warned that fishing at the F_{max} level might result in over-exploitation of little skate due to their low fecundity.

The SARC used recent NEFSC spring and autumn survey cumulative length distributions (1994-1999), and recent landed skate cumulative length distributions from NEFSC sea sampling of the commercial fishery (1994-1999) to develop a contemporary estimate of the length (L_{50} = 45 cm) and age of recruitment of little skate to the commercial fisheries for use in a Thompson and Bell (1936) yield per recruit analysis (YPR). Waring's growth parameters were used to convert lengths to age. NEFSC length-weight equations from the 1991-1999 surveys were used to convert mean lengths at age to mean weights at age. In the current analysis, little skate do not approach full recruitment to the fisheries until age 4 (70% at age 3, 90% at age 4, 100% at ages 5 to 8), F_{max} is undefined, and $F_{0.1}$ = 0.65, about 33% higher than Waring's (1984) analysis. Input data and the results of Thompson and Bell (1936) yield and spawning biomass per recruit calculations for little skate are presented in Table B30 of the SAW 30 documents.

The SARC has concluded that yield per recruit based reference points for little skate in the northeast region are unreliable, due to the use of outdated growth parameters from the 1970s and the uncertainty of partial recruitment to the commercial fishery. A threshold fishing mortality reference is therefore proposed for little skate based on the estimate of the natural mortality rate (M). **For little skate, the SARC recommends F = M = 0.40 as a proxy for the SFA threshold fishing mortality reference point. The SARC proposes use of the 75th percentile value of the NEFSC spring biomass indices for the GOM-MA inshore and offshore regions during 1982-1999 as a proxy for the SFA target biomass reference point for little skate (6.54 kg/tow), and one-half of that value as the SFA threshold biomass reference point for little skate (3.27 kg/tow; Figure 41).**

2.3.2.3 Barndoor Skate

Barndoor skates are presumed to be a relatively long-lived, slow growing species, but no estimates of age and growth parameters are currently available. Casey and Myers (1998) proposed that barndoor skate might have characteristics similar to the European common skate, (*Raja batis*). By analogy, Casey and Myers (1998) suggested an L_{max} of 153 cm, A_{mat} of 11 years, and F of 47 egg cases per year for barndoor skate. Using Frisk's (1999) predictive equations and the NEFSC survey maximum observed length of 136 cm provides estimates of L_{mat} of 102 cm and A_{mat} of 8 years.

Graduate students and staff from the Virginia Institute of Marine Science (VIMS) have sampled barndoor skate while conducting research aboard commercial scallop vessels participating in the Sea Scallop Exemption Program in Closed Area II on Georges Bank (Gedamke and DuPaul 1999). The vessels fished with two 15 foot New Bedford style scallop dredges towing in 30-40 fathoms of water at 5-6 knots. Between June 15 and October 5, 1999, six trips lasting between five and twelve days were completed, with four more planned before December 31, 1999. Although barndoor skate were not a significant percentage of the total bycatch weight, they were observed frequently enough to contribute to a significant database of allometric and morphometric measurements. Biological samples, including reproductive tracts, vertebrae, and tissue samples were collected for age, growth, reproductive, and population genetics studies (Gedamke and DuPaul 1999).

To date, VIMS scientists have observed 916 barndoor skates, with 52.3% (n=479) females and 47.7% (n=437) male. Disk width, disk length, total length, clasper length, and clasper width measurements were taken from all individuals. Total length ranged from 20.0 to 129.4 cm with an average of 55.7 cm and a median of 52.9 cm. Clasper length measurements show male sexual maturity to occur at approximately 100 cm total length. Samples of reproductive tracts have also been collected to determine female maturation size (n=69) and verify the male allometric plot (n=66). In addition, vertebrae samples have been collected from 251 individuals for age and growth studies. Gedamke and DuPaul (1999) stressed that their data are preliminary, are part of an ongoing study, and are from only a portion of Closed Area II. Data has also been collected from the Nantucket Lightship Closed Area and Georges Bank Closed Area I, and the VIMS scientists are continuing their ongoing research efforts with the commercial scallop fleet.

Historical Canadian survey data (e.g., as presented in Casey and Myers (1998) from St. Pierre Bank to Brown's Bank) suggest that a substantial decline in barndoor skate biomass in the northern part of the species' range had occurred by the time that standardized NEFSC surveys began in U.S. waters in 1963. If the barndoor skate in U.S. waters are a part of the same unit stock as that in Canadian waters, then the high indices in the NEFSC surveys during the early 1960s likely indicate a biomass well below B_{MSY}. The linkage between barndoor skates in U.S. and Canadian waters, however, is unknown. **For barndoor skate, there are insufficient data on age and growth to determine fishing mortality rates or propose SFA fishing mortality reference points. The SARC proposes use of the mean value of the NEFSC autumn biomass indices for the GOM-SNE offshore region during 1963-1966 as a proxy for the SFA target biomass reference point for barndoor skate (1.62 kg/tow), and one-half of that value as the SFA threshold biomass reference point for barndoor skate (0.81 kg/tow; Figure 41).**

2.3.2.4 Thorny Skate

Simon and Frank (1996) reported that nearly all thorny skate smaller than 50 cm sampled during a 1996 research cruise were immature, while nearly all skate larger than 50 cm were mature. These results were comparable to maturity studies of thorny skate conducted by Templeman (1982) on the Newfoundland shelf.

Frisk (1999) references Templeman (1965) for estimates of L_{max} = 102 cm and a maximum age of 20 years, which would infer a value for M of 0.2. Frisk's (1999) predictive equations and the NEFSC survey L_{max} of 111 cm provides estimates of L_{mat} of 84 cm and A_{mat} of seven years. **There are insufficient data on the age and growth of thorny skate to determine fishing mortality rates or propose SFA fishing mortality reference points. The SARC proposes use of the 75th percentile value of the NEFSC autumn biomass indices for the GOM-SNE offshore region during 1963-1998 as a proxy for the SFA target biomass reference point for thorny skate (4.41 kg/tow), and one-half of that value as the SFA threshold biomass reference point for thorny skate (2.20 kg/tow; Figure 41).**

2.3.2.5 Smooth Skate

Frisk's (1999) predictive equations and the NEFSC survey L_{max} of 71 cm provides estimates of L_{mat} of 56 cm and A_{mat} of 5 years. **There are insufficient data on the age and growth of smooth skate to determine fishing mortality rates or propose SFA fishing mortality reference points. The SARC proposes use of the 75th percentile value of the NEFSC autumn biomass indices for the GOM-SNE offshore region during 1963-1998 as a proxy for the SFA target biomass reference point for smooth skate (0.31 kg/tow), and one-half of that value as the SFA threshold biomass reference point for smooth skate (0.16 kg/tow; Figure 41).**

2.3.2.6 Clearnose Skate

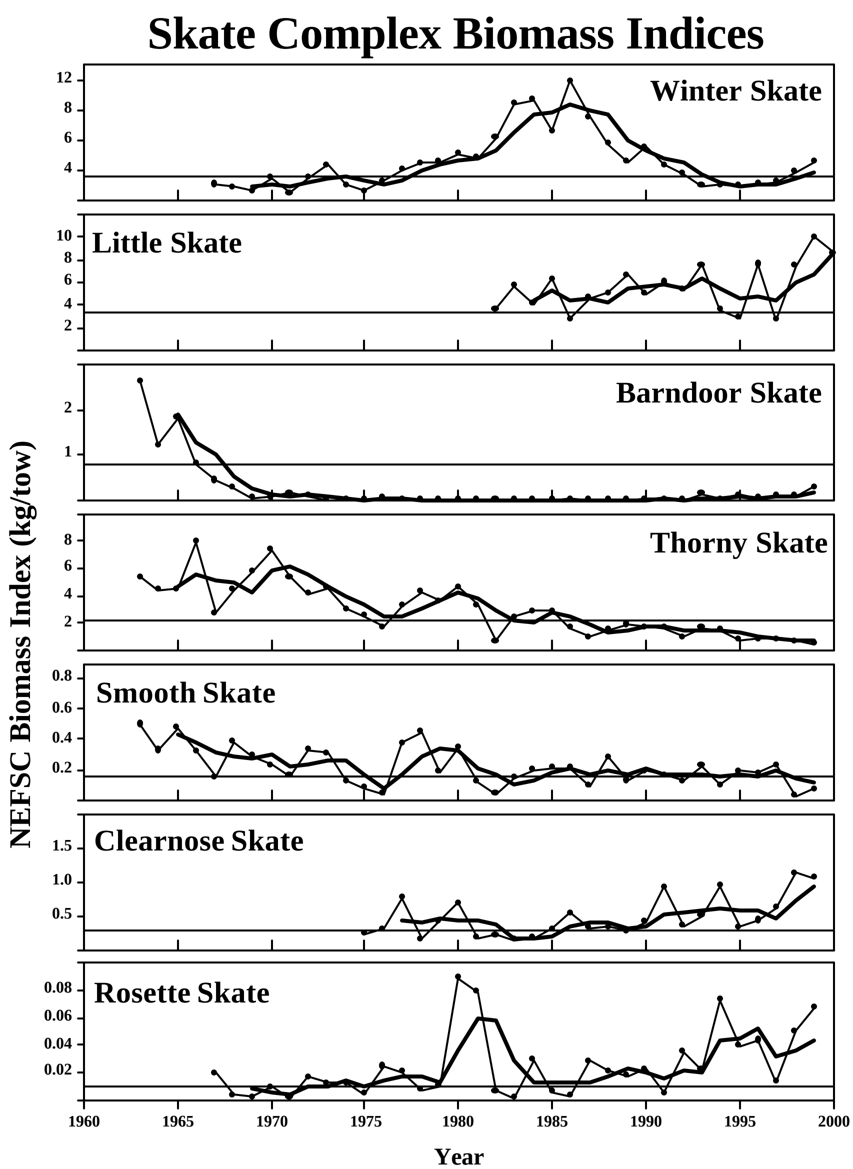
Frisk (1999) references McEachran (In press) as the source for estimates of L_{max} = 128 cm and L_{mat} = 66 cm, and a maximum age of seven years Frisk's (1999) predictive equations and the NEFSC survey L_{max} of 78 cm provides estimates of L_{mat} of 61 cm and A_{mat} of five to six years. **There are insufficient data on the age and growth of clearnose skate to determine fishing mortality rates or propose SFA fishing mortality reference points. The SARC proposes use of the 75th percentile value of the NEFSC autumn biomass indices for the Mid-Atlantic inshore and offshore regions during 1975-1998 as a proxy for the SFA target biomass reference point for clearnose skate (0.56 kg/tow), and one-half of that value as the SFA threshold biomass reference point for clearnose skate (0.28 kg/tow; Figure 41).**

2.3.2.7 Rosette Skate

Frisk (1999) references McEachran (In press) as the source for estimates of L_{max} = 46 cm and L_{mat} = 36 cm. Frisk's (1999) predictive equations and the NEFSC survey L_{max} of 57 cm provides estimates of L_{mat} of 46 cm and A_{mat} of four years. **There are insufficient data on the age and growth of rosette skate to determine fishing mortality rates or propose SFA fishing mortality reference points. The SARC proposes use of the 75th percentile value of the NEFSC autumn biomass indices for the Mid-Atlantic offshore region during 1967-1998 as a proxy for the SFA target biomass reference point for rosette skate (0.029 kg/tow), and one-half of that value as the SFA threshold biomass reference point for rosette skate (0.015 kg/tow; Figure 41).**

Figure 41 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 proposed biomass thresholds.



2.3.2.8 Summary

In summary, the SARC developed the following biological reference points for each of the seven species of skates in the northeast complex. These reference points are likely to be reviewed by the Skate PDT when developing alternatives for overfishing definitions to be considered by the Council for the Skate FMP. An evaluation of each species' status in the context of the following reference points is provided in the following section of this document.

Table 21 Summary of Biological Reference Points for Skates Developed by the SARC at SAW 30

SKATE SPECIES	TARGET BIOMASS (B_{target})	THRESHOLD BIOMASS ($B_{threshold}$)	TARGET FISHING MORTALITY (F_{target})	THRESHOLD FISHING MORTALITY ($F_{threshold}$)
Winter	6.46	3.23	0.10	0.10
Little	6.54	3.27	0.40	0.40
Barndoor	1.62	0.81	N/A	N/A
Thorny	4.41	2.20	N/A	N/A
Smooth	0.31	0.16	N/A	N/A
Clearnose	0.56	0.28	N/A	N/A
Rosette	0.03	0.01	N/A	N/A

2.3.3 Evaluation of Fishing Mortality and Stock Abundance

The length-based mortality estimators of Beverton and Holt (1956) and Hoenig (1987) were considered for the estimation of fishing mortality rates for winter and little skates from NEFSC spring length frequency distributions. The NEFSC spring survey series exhibit both a long time series and the least evidence of continuous trends in recruitment for the two species, making it amenable for use with these estimators, which can be biased by trends or extreme variation in recruitment over time.

The Beverton and Holt (1956) estimator is:

$$Z = (K(L_{inf} - L_{bar})) / (L_{bar} - L'),$$

and the Hoenig (1987) estimator is:

$$Z = \ln [(e^{-K}(L_{bar}-L_{inf}) + L_{inf} - L') / (L_{bar} - L')].$$

For both estimators, L' = the lower limit of the length class in which the fish are assumed fully recruited to the sampling or fishing gear, and L_{bar} = the mean length of fish above L' in the sample length distributions. Hoenig's (1987) estimator reportedly avoids the positive bias in estimates calculated with the Beverton and Holt (1956) estimator for samples in which L' approaches L_{bar}. The SARC concluded that the Hoenig (1987) estimates are more reliable, and those are the fishing mortality rates referenced below. Estimates were calculated for 5 year (winter skate) and 3 year (little skate) moving groups, or windows, of years to smooth the variation in the mortality estimates caused by variations in recruitment over time.

The following subsections describe estimates of mortality for winter and little skates. No age and growth parameters were available for the other five species in the complex, and so no mortality estimates have been made.

2.3.3.1 Winter Skate

Investigation of the NEFSC spring survey length frequencies determined that the appropriate value for L' was 50 cm, based on the time series average of the one-cm length intervals with the most abundant survey catches. The von Bertalanffy growth parameters reported in Simon and Frank (1996) were used in the mortality rate estimator, and initially a value of M = 0.2 was used based on assumed maximum age of about 20 years.

For M = 0.2, Hoenig (1987) estimates of F for winter skate were about 0.2 during the 1970s, falling to very low levels during the 1980s, and then increasing during the 1990s to 0.2-0.3. The very low to negative values of F during the 1980s with M = 0.2, however, indicated that some of the parameters used in the estimators (either the growth parameters, L', or M) might be mis-specified, and so the fishing mortality estimates may be negatively biased. Frisk's (1999) work suggests that the M/K ratio for skates is about 1.0. Taking into consideration the Simon and Frank (1996) of K = 0.14, the SARC concluded that a value of M = 0.1, and an inferred maximum age of 30 years, was appropriate for winter skate.

With M=0.1, fishing mortality on winter skate was estimated to be about 0.30, well above the proposed SFA threshold of F = 0.10, during the early to mid 1970s (Table 22, Figure 42). Fishing mortality decreased in concert with a drop in reported landings of all species of skates and an increase in abundance of winter skate during the late 1970s and into the mid 1980s. Fishing mortality was near or below F = 0.1 during 1979-1992 (Table 22, Figure 42). Fishing mortality on winter skate has increased during the 1990s as reported landings of all species of skates have increased and the abundance of winter skate has decreased. The fishing mortality rate on winter skate peaked in 1998 at 0.41 and decreased in 1999 and 2000. The current fishing mortality rate on winter skate is estimated to be 0.34, higher than the proposed SFA threshold of F = 0.10 (Table 22, Figure 42).

Due to the inter-annual variation in skate survey indices of abundance, the most recent three-year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For winter skate, the 1996-1998 NEFSC autumn survey biomass index average of 2.83 kg/tow is below the proposed SFA biomass target and threshold reference points of 6.46 kg/tow and 3.23 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 3.77 kg/tow is below the biomass target of 6.46 kg/tow, but above the proposed SFA biomass threshold of 3.23 kg/tow.

Table 22 Hoenig (1987) Estimates of Fishing Mortality for Winter Skate Estimated from NEFSC Spring Trawl Survey Length Frequency Distributions

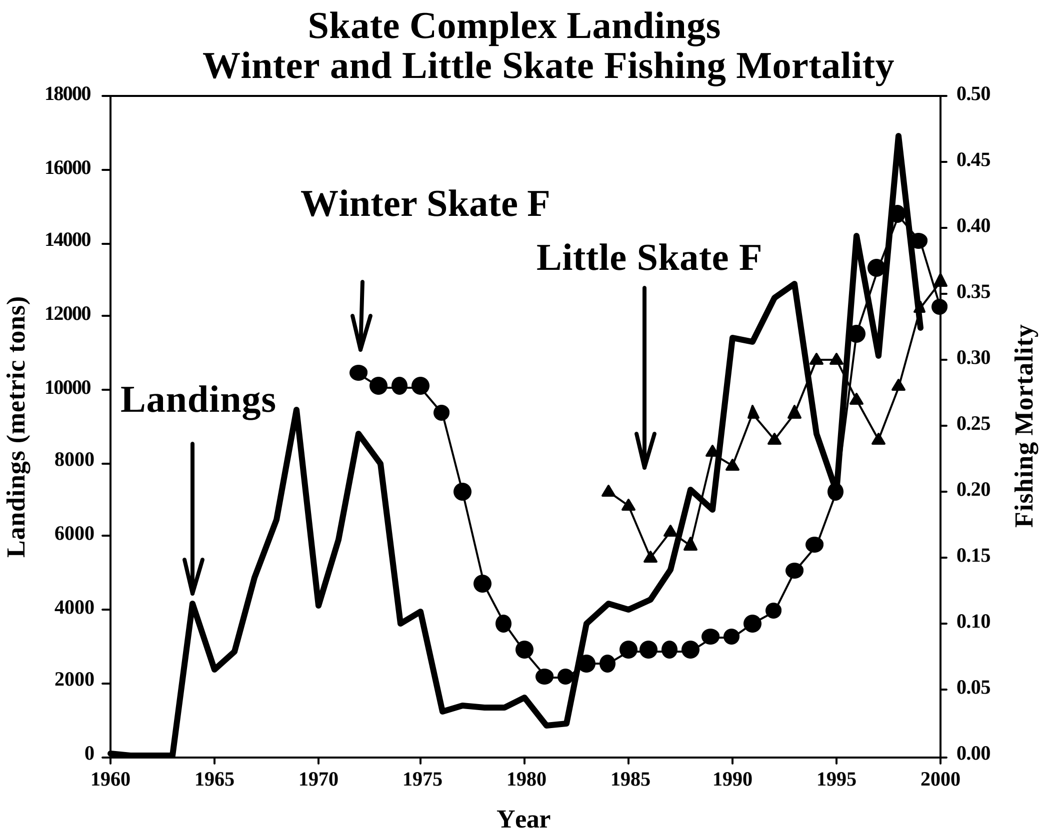
Winter skate von Bertalanffy growth parameters from Simon and Frank (1996); assumes recruitment to NEFSC survey sampling gear at 50 cm; year of estimate is the last year of a five-year moving window, to smooth the variation in estimates resulting from variation in recruitment over time.

Winter skate: Linf = 114.01 cm, K = 0.14405, Spring survey L' = 50 cm, M = 0.1

Year	L_{bar}	Hoenig F		Year	L_{bar}	Hoenig F
1972	63.9	0.29		**1986**	75.9	0.08
1973	64.2	0.28		**1987**	75.6	0.08
1974	64.3	0.28		**1988**	75.5	0.08
1975	64.5	0.28		**1989**	74.9	0.09
1976	65.0	0.26		**1990**	74.7	0.09
1977	67.6	0.20		**1991**	74.4	0.10
1978	72.0	0.13		**1992**	73.3	0.11
1979	74.0	0.10		**1993**	71.2	0.14
1980	76.4	0.08		**1994**	69.7	0.16
1981	77.5	0.06		**1995**	67.6	0.20
1982	77.6	0.06		**1996**	63.1	0.32
1983	77.1	0.07		**1997**	61.6	0.37
1984	76.8	0.07		**1998**	60.7	0.41
1985	76.0	0.08		**1999**	61.1	0.39
				2000	62.4	0.34

Figure 42 Commercial Fishery Landings of Skates (All Species) in the Northeast Region

Winter and little skate fishing mortality rates calculated from NEFSC spring survey length distributions.



2.3.3.2 Little Skate

Waring (1984) used catch curve analysis of the NEFSC survey catch at age data for 1968-1978 to estimate an instantaneous total mortality rate (Z) for little skate of 1.76 in the early 1970s, which declined to 0.54 in the late 1970s. Assuming values of instantaneous natural mortality (M) of 0.4-0.5, Waring inferred that fishing mortality rates therefore ranged from 1.26-1.35 in the early 1970s to 0.17 to 0.27 in the late 1970s.

Investigation of the NEFSC winter, spring, and autumn length frequencies determined that the appropriate value for L' was 45 cm in the NEFSC winter, spring and autumn surveys, based on the time series average of the one-cm length intervals with the most abundant survey catches. Investigation of NEFSC survey cumulative length distributions (1994-1999) and recent landed skate cumulative length distributions from NEFSC sea sampling of the commercial fishery (1994-1999) indicated that the contemporary estimate of the length of recruitment to the fishery was very similar, at 43 cm, and so fishing mortality estimates with the survey L' = 45 cm are considered valid estimates of the fully recruited fishing mortality rate. The von Bertalanffy growth parameters reported in Waring (1984) were used in both mortality rate estimators, and a value of M = 0.4 was used based on an assumed maximum age of about eight years.

The time series of little skate mortality begins with the 1982-1984 three year window (1984 in Table 23) to ensure a series with consistent survey vessel and gear catch conversion factors. Estimates of fishing mortality for little skate have risen from about 0.20 during 1984-1990 to about 0.30 during the 1990s. The estimates of fishing mortality for little skate are sensitive to small changes in the value of L_{bar} (about 47 cm), which is both within the large accumulation of skates between 40 and 50 cm in the most annual NEFSC spring length frequency distributions (Figures B33-B34 in the SAW 30 documents) and within six cm of L_{inf} (53 cm). The 1997-1999 increase in F (1999 in Table 23) is due to a time series low value of L_{bar}, and that in turn is due at least in part to recent increased abundance of smaller skates in the survey length distributions (Figure B34 in the SAW 30 documents). Thus, the apparent recent increase in fishing mortality of little skate from the spring survey may be an artifact of recently improved recruitment. The current fishing mortality rate on little skate is estimated to be 0.34, lower than the proposed SFA threshold of F = 0.40 (Table 23, Figure 42).

Table 23 Beverton-Holt (1956) and Hoenig (1987) Estimates of Fishing Mortality for Little Skate Estimated from NEFSC Spring Trawl Survey Length Frequency Distributions

Little skate von Bertalanffy growth parameters from Waring (1984); assumes recruitment to NEFSC spring survey sampling gear at 45 cm in; year of estimate is the last year of a three year moving window, to smooth the variation in estimates resulting from variation in recruitment over time.

Little skate: Linf = 52.73 cm, K = 0.352, Spring survey L' = 45 cm, M = 0.4

Year	L_{bar}	Hoenig F
1984	47.1	0.20
1985	47.1	0.19
1986	47.2	0.15
1987	47.2	0.17
1988	47.2	0.16
1989	47.0	0.23
1990	47.0	0.22
1991	46.9	0.26
1992	46.9	0.24
1993	46.9	0.26
1994	46.8	0.30
1995	46.8	0.30
1996	46.8	0.27
1997	46.9	0.24
1998	46.8	0.28
1999	46.7	0.34
2000	46.6	0.36

Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For little skate, the 1997-1999 NEFSC spring survey biomass index average of 6.72 kg/tow is above the proposed SFA biomass target and threshold reference points of 6.54 kg/tow and 3.27 kg/tow. Updated for the 1998-2000 NEFSC spring survey, the three-year index average of 8.68 kg/tow is above both the proposed SFA biomass target of 6.54 kg/tow and threshold of 3.27 kg/tow.

2.3.3.3 Barndoor Skate

For barndoor skate, there are insufficient data on age and growth to determine fishing mortality rates. Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For barndoor skate, the 1996-1998 NEFSC autumn survey biomass index average of 0.08 kg/tow is below the proposed SFA biomass target and threshold reference points of 1.62 kg/tow and 0.81 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 0.17 kg/tow is below both the proposed SFA biomass target of 1.62 kg/tow and threshold of 0.81 kg/tow.

2.3.3.4 Thorny Skate

For thorny skate, there are insufficient data on age and growth to determine fishing mortality rates. Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For thorny skate, the 1996-1998 NEFSC autumn survey biomass index average of 0.77 kg/tow is below the proposed SFA biomass target and threshold reference points of 4.41 kg/tow and 2.20 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 0.66 kg/tow is below both the proposed SFA biomass target of 4.41 kg/tow and threshold of 2.20 kg/tow.

2.3.3.5 Smooth Skate

For smooth skate, there are insufficient data on age and growth to determine fishing mortality rates. Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For smooth skate, the 1996-1998 NEFSC autumn survey biomass index average of 0.15 kg/tow is below the proposed SFA biomass target and threshold reference points of 0.31 kg/tow and 0.16 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 0.11 kg/tow is below both the proposed SFA biomass target of 0.31 kg/tow and threshold of 0.16 kg/tow.

2.3.3.6 Clearnose Skate

For clearnose skate, there are insufficient data on age and growth to determine fishing mortality rates. Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For clearnose skate, the 1996-1998 NEFSC autumn survey biomass index average of 0.72 kg/tow is above the proposed SFA biomass target and threshold reference points of 0.56 kg/tow and 0.28 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 0.93 kg/tow is above both the proposed SFA biomass target of 0.56 kg/tow and threshold of 0.28 kg/tow.

2.3.3.7 Rosette Skate

For rosette skate, there are insufficient data on age and growth to determine fishing mortality rates. Due to the inter-annual variation in skate survey indices of abundance, the most recent three year averages of the indices were used to evaluate current status with respect to the proposed SFA biomass reference points. For rosette skate, the 1996-1998 NEFSC autumn survey biomass index average of 0.040 kg/tow is above the proposed SFA biomass target and threshold reference points of 0.029 kg/tow and 0.015 kg/tow. Updated for the 1997-1999 NEFSC autumn survey, the three-year index average of 0.043 kg/tow is above both the proposed SFA biomass target of 0.029 kg/tow and threshold of 0.015 kg/tow.

2.3.4 Summary of Assessment Results

Conclusions about the status of the seven species in the northeast US region skate complex are based mainly on standardized research trawl survey data collected by the US and Canada during 1963-1999. Taken as a group, the skate biomass for the seven species in the northeast region is at a medium level. For the aggregate complex, the NEFSC spring survey index of biomass was relatively constant from 1968 to 1980, then increased significantly to peak levels in the mid to late 1980s. The index of skate complex biomass then declined steadily until 1994, but recently began to increase again (Figure 1). The large increase in skate biomass in the mid to late 1980s was dominated by winter and little skate. The biomass of large-sized skates (>100 cm maximum length; barndoor, winter, and thorny) has steadily declined since the mid-1980s. The recent increase in aggregate skate biomass has been due to an increase in small-sized skates (<100 cm maximum length; little, clearnose, rosette, and smooth), mainly little skate (Figure 2).

Winter skate abundance is currently about same as in the early 1970s, at about 25% of the peak observed during the mid 1980s. Comparison of the current fishing mortality rate (NEFSC spring survey; F = 0.39) to the proposed SFA threshold fishing mortality reference point (F = M = 0.1) indicates that overfishing for winter skate is occurring (Figure 42). While the 1996-1998 NEFSC autumn survey biomass index average of 2.83 kg/tow fell below the proposed SFA biomass threshold reference point of 3.23 kg/tow, the 1997-1999 index average of 3.77 kg/tow is above the proposed threshold reference point (Figure 41). Winter skate is not overfished, but overfishing is occurring.

Little skate abundance began to increase in the early 1980s, and has increased to the highest abundance since 1975. Comparison of the current fishing mortality rate (NEFSC spring survey; F = 0.34) to the proposed SFA threshold fishing mortality threshold reference point (F = M = 0.4) indicates that overfishing for little skate is not occurring (Figure 42). The 1998-2000 NEFSC spring survey biomass index average of 8.68 kg/tow is above the proposed SFA biomass threshold reference point of 3.27 kg/tow and target of 6.54 kg/tow (Figure 41). Little skate is not overfished, and overfishing is not occurring.

The abundance of barndoor skate declined continuously through the 1960s to historic lows during the early 1980s. Since 1990, the abundance of barndoor skate has increased slightly on Georges Bank, the western Scotian Shelf and in Southern New England, although the current NEFSC autumn survey biomass index is still less than 5% of the peak observed in 1963. The fishing mortality rate could not be estimated for the stock nor could a fishing mortality reference point be determined. The 1997-1999 NEFSC autumn survey biomass index of 0.17 kg/tow is below the proposed SFA biomass threshold reference point of 0.81 kg/tow (Figure 41). Barndoor skate is overfished.

The abundance of thorny skate has declined to historic lows. Current abundance is about 10%-15% of the peak observed in the late 1960s to early 1970s. The fishing mortality rate could not be estimated for the stock, nor could a fishing mortality reference point be determined. The 1997-1999 NEFSC autumn survey biomass index of 0. 66 kg/tow is below the proposed SFA biomass threshold reference point of 2.20 kg/tow (Figure 41). Thorny skate is overfished.

The abundance of smooth skate was highest during the early 1960s and late 1970s. The fishing mortality rate could not be estimated for the stock, nor could a fishing mortality reference point be determined. The 1997-1999 NEFSC autumn survey biomass index of 0. 11 kg/tow is below the proposed SFA biomass threshold reference point of 0.16 kg/tow (Figure 41). Smooth skate is overfished.

The abundance of clearnose skate has been increasing since the mid 1980s. The fishing mortality rate could not be estimated for the stock, nor could a fishing mortality reference point be determined. The 1997-1999 NEFSC autumn survey biomass index of 0.93 kg/tow is above the proposed SFA biomass threshold reference point of 0.28 kg/tow and the proposed biomass target of 0.56 kg/tow (Figure 41). Clearnose skate is not overfished.

The abundance of rosette skate has been increasing since 1986. The fishing mortality rate could not be estimated for the stock, nor could a fishing mortality reference point be determined. The 1997-1999 NEFSC autumn survey biomass index of 0.043 kg/tow is above both the proposed SFA biomass threshold reference point of 0.015 kg/tow and the proposed target of 0.029 kg/tow (Figure 41). Rosette skate is not overfished.

Table 24 summarizes the current status of each species of skate in the northeast complex with respect to the proposed reference points developed by the SARC. All numbers have been updated through the 1999 autumn and 2000 spring survey, and therefore, the stock status determinations may not be the same as those presented in the SAW 30 documents. For example, winter skate is no longer considered overfished relative to the proposed reference points.

Table 24 Summary of Current Status of Skate Species Relative to the SAW 30 Proposed Reference Points

	PROPOSED				PROPOSED			
SPECIES	**B_{target}**	**$B_{threshold}$**	**Current B**	**Biomass Status**	**F_{target}**	**$F_{threshold}$**	**Current F**	**F Status**
Winter	6.46	3.23	3.77	Not Overfished	0.10	0.10	0.34	Overfishing
Little	6.54	3.27	8.68	Not Overfished	0.40	0.40	0.36	Not Overfishing
Barndoor	1.62	0.81	0.17	Overfished	---	---	---	Unknown
Thorny	4.41	2.20	0.66	Overfished	---	---	---	Unknown
Smooth	0.31	0.16	0.11	Overfished	---	---	---	Unknown
Clearnose	0.56	0.28	0.93	Not Overfished	---	---	---	Unknown
Rosette	0.03	0.01	0.04	Not Overfished	---	---	---	Unknown

2.3.5 SARC Comments

The SARC noted that the landings attributable to species are very uncertain, since over 99% of the landings records are reported as "unclassified skates." This is due both to the difficulties of species identification, and the uncertainty of the relative proportions of skate landed as wings specifically for human consumption (likely winter or thorny skate), for use as bait (likely little skate), or as whole fish.

The SARC discussed the species identification problems which may also exist in survey data, particularly for winter and little skate at sizes less than 35 cm. Currently, the NEFSC survey data are audited such that the proportions (on a per tow basis) of winter and little skate less than

35 cm reflect the proportions greater than 35 cm, for tows with a significant mix of winter and little skate. With the increased participation of volunteers on NEFSC surveys over the last 3-4 years, skate identification may be more uncertain than during earlier years.

The SARC discussed that assumption of the natural mortality rate for winter skate, and noted that the preference for the value of M = 0.1 was based on growth rate estimates available from Canadian waters (Simon and Frank, 1996; K = 0.14) and the work of Frisk (1998) which suggest an M/K ratio for elasmobranchs of about 1.0. The SARC further noted that application of the Hoenig (1983) method to estimate natural mortality ($\ln[M] = 1.44 - 0.982*\ln[t_{max}]$) provided an estimate of M = 0.15 for a potential maximum age of 30 years.

The SARC noted that clearnose skate have a more southern distribution compared to the other skates considered in the northeast region's skate complex, and the survey data considered in this assessment likely reflect trends for only the northern component of the population or stock along the Atlantic coast. It was also noted that abundance of clearnose skate may be increasing in recent years due to recent declines in the abundance of the primary predators of clearnose skate, including sand tigers and other large coastal sharks.

There was general discussion among SARC members as to whether sustainable yield reference points were appropriate for large sized skates such as winter, thorny and barndoor, since they are generally characterized by relatively slow growth and low intrinsic rates of population increase. It was noted that reference points based on threshold levels or indices of spawning biomass may be more appropriate for these species, since recruitment success is more closely related to standing spawning stock biomass than for most teleost stocks. It was also noted that a major source of fishing mortality is bycatch and therefore yield based reference points may not be appropriate. The SARC acknowledged, however, that SFA reference points need to be formulated with consideration of maximum sustainable yields. Given the lack of stock-recruitment data, the SARC recommended that fishing mortality rate targets be set to rate of natural mortality.

The SARC noted that historical NEFSC survey data, from the Albatross III cruises during 1948-1962, should be investigated when they become readily accessible, as they may provide valuable historical context for long term trends in skate biomass.

2.4 STATUS OF BARNDOOR SKATE RELATIVE TO THE ENDANGERED SPECIES ACT (ESA)

On January 15, 1999, NMFS requested information from the public on barndoor skate for possible inclusion on the list of candidate species under the Endangered Species Act (ESA). On March 4, 1999, NMFS received a petition from GreenWorld to list barndoor skate as endangered or threatened and to designate Georges Bank and other appropriate areas as critical habitat. The petitioners also requested that barndoor skate be listed immediately, as an emergency matter. On April 2, 1999, NMFS received a petition from the Center for Marine Conservation (CMC) to list barndoor skate as an endangered species. The second petition was considered by NMFS as a comment on the first petition submitted by GreenWorld. Both the petition and comment referenced a paper in the journal *Science*, which presents data on the decline of barndoor skates (Casey and Myers, 1998).

On June 21, 1999, a “Notice of petition finding; request for information and comments” was published by NMFS in the Federal Register. This notice indicated that the petition to add the barndoor skate to the list of threatened and endangered wildlife and to designate critical habitat may be warranted. In addition, the notice solicited information and data on the barndoor skate from any interested party, and announced that NMFS would conduct a stock assessment to determine if the petitioned action was warranted.

Under Section 4(a)(1) of the Endangered Species Act, a species can be determined to be endangered or threatened for any of the following factors: (1) present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or manmade factors affecting its continued existence. Listing determinations are based on the best scientific and commercial data available after taking into account any efforts being made by any state or foreign nation to protect the species.

At the 30th SAW in November 1999, the SARC reviewed each of the above listing criteria relative to barndoor skate and provided an assessment and the recommendations and comments summarized below.

To ensure that the assessment review conducted by the SARC was complete and based on the best available scientific and commercial data, NMFS solicited information on the species' current and historic distribution and abundance and any information related to the five listing factors identified above. The SARC reviewed this information, from the Marine Conservation Biology Institute, the Virginia Institute of Marine Science, the Center for Marine Conservation, and the Trawlers Survival Fund, in addition to commercial fishery and state and federal (both US and Canadian) research survey data, in developing comments on the five ESA listing factors.

The SARC reviewed barndoor skate with respect to the five ESA listing factors and found that there was no evidence that they were in danger of extinction or likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Research surveys indicate that barndoor skate biomass in waters off the east coast of North America has declined substantially from peak levels prior to the 1960s to very low levels during the 1970s and 1980s. Recently, barndoor skate abundance and biomass have begun to increase in surveys in USA and Canadian waters. Barndoor skate also occur in waters deeper than covered by these surveys, and the surveys under-represent the abundance of larger barndoor skate. Listing determinations are based on the best scientific and commercial data available after taking into account any efforts being made by any state or foreign nation to protect the species. With regard to each of these five listing factors:

(1) Barndoor skate have persisted in their core habitat in USA waters at very low abundance since the late 1960s. Although barndoor skate were not observed in survey catches in many parts of its potential range during the past two decades, it is now occurring in some areas, particularly on the western Scotian Shelf, on Georges Bank, and in offshore waters off Southern New England. There is no evidence of a contraction in range, but present

low abundance may reflect local reductions in area of occupancy. Thus, the available evidence does not suggest that the habitat or range of barndoor skate has been destroyed, modified, or curtailed to an extent that threatens the existence of the species.

(2) Given the high level of distant water fleet and domestic fishing effort that occurred in the barndoor skate habitat during the last 40 years (see Figure B109 in the SAW 30 documents), fishing mortality, mainly as bycatch, was likely a factor contributing to the decline in barndoor skate abundance. Although fishing and natural mortality rates of barndoor skate cannot be quantified, the small but sustained increase in research survey catches indicates that annual survival rates are currently high enough to allow for some recovery. Therefore, it appears that barndoor skate are not currently overutilized for commercial, recreational, scientific or educational purposes.

(3) There is no scientific evidence to suggest that barndoor skate in the waters of the Northeast Coast of the USA are subject to an unusual degree of disease or predation.

(4) There are no current regulations specifically governing the harvest of barndoor skate. However, fisheries in which barndoor skate are taken as by-catch have been subject to increasingly restrictive regulations over the past decade which may have provided some protection over some parts of its range. Following the progressive implementation of the regulations, survivorship of barndoor skate has recently been high enough to allow abundance and biomass to increase to some extent. However, if current effort limitation and closed area restrictions on Georges Bank and southern New England are relaxed, continued increases in abundance may be hindered.

(5) Although the combination of continued low abundance, suspected low intrinsic rate of increase and suspected late age of maturity make barndoor skate vulnerable to extirpation, the species has persisted at low levels in USA waters over the past 30-40 years. Thus, there is no scientific evidence to suggest that barndoor skate have been subject to unusual natural or anthropogenic factors that threaten its continued existence.

As previously discussed, NMFS received a petition from GreenWorld to list barndoor skate as endangered or threatened and to designate Georges Bank and other appropriate areas as critical habitat on March 4, 1999. The ESA requires NMFS to make a finding as to whether or not the petitioned action is warranted within one year of the receipt of the petition. As of the date of this SAFE Report, NMFS has not published a decision.

3.0 FISHERY EVALUATION INFORMATION

The purpose of this section is to describe and characterize the various fisheries in which skates are caught. Descriptive information on the fisheries is included, and where possible, quantitative commercial fishery and economic information is presented. Since very little is known about directed skate fishing, much of the descriptive information contained in this section was compiled by Skate PDT members through a series of interviews and discussions with participants in the skate fishery. Council staff and PDT members met with skate industry members on June 19, 2000 in Rhode Island to discuss aspects of the skate bait fishery (skates caught for lobster bait). In addition, several fishermen and buyers throughout the region, representatives from industry associations, and representatives from several processing facilities provided information to characterize both the skate bait fishery and the skate wing fishery. A list of individuals who contributed information presented in this report appears in Section 6.0.