## B. SKATE COMPLEX: ASSESSMENT SUMMARY F0R 2006

**State of Stock:** For the aggregate skate complex (comprising seven species), the NEFSC spring survey index of relative biomass was relatively stable during the 1970s, and then increased in the mid to late 1980s. The biomass index then declined until 1994, increased until 2000, and has since decreased (Figure B1-A). If the species in the complex are divided into large- (barndoor, winter, and thorny) and small-sized skates (little, clearnose, rosette, and smooth), it is evident that the increase in skate biomass in the mid to late 1980s was due to increases in winter and little skate (Figures B1-B and B1-C). The biomass of large-sized skates declined steadily from the mid-1980s to the mid-1990s and has since been stable (Figure B1-B). The increase in aggregate skate biomass from the mid-1990s to 2000 reflected an increase in little skate and the subsequent decline in biomass reflected decreases in little skate (Figure B1-C).

For winter skate, the 2003-2005 NEFSC autumn survey biomass index average of 3.34 kg/tow is below the biomass target of 6.46 kg/tow but above the threshold reference point of 3.23 kg/tow (Figure B2). Winter skate is thus not overfished. The 2003-2005 average of 3.34 kg/tow was more than 20% below the 2002-2004 average of 4.34 kg/tow; therefore, overfishing is occurring for winter skate (This uses the 2005 survey as the most recent data).

For little skate, the 2004-2006 NEFSC spring survey biomass index average of 4.59 kg/tow is below the biomass target of 6.54 kg/tow but above the threshold reference point of 3.27 kg/tow (Figure B2). Little skate is thus not overfished. The 2004-2006 average of 4.59 kg/tow was less than 20% below the 2003-2005 average of 5.65 kg/tow; therefore, overfishing is not occurring for little skate.

For barndoor skate, the 2003-2005 NEFSC autumn survey biomass index average of 0.96 kg/tow is below the biomass target of 1.62 kg/tow but above the threshold reference points of 0.81 kg/tow (Figure B2). Barndoor skate is thus not overfished. The 2003-2005 average of 0.96 kg/tow was above the 2002-2004 average of 0.88 kg/tow; therefore, overfishing is not occurring for barndoor skate.

For thorny skate, the 2003-2005 NEFSC autumn survey biomass index average of 0.56 kg/tow is below the biomass target and threshold reference points of 4.41 kg/tow and 2.20 kg/tow (Figure B2). Thorny skate is thus overfished. The 2003-2005 average of 0.56 kg/tow was less than 20% below the 2002-2004 average of 0.63 kg/tow; therefore, overfishing is not occurring for thorny skate.

For smooth skate, the 2003-2005 NEFSC autumn survey biomass index average of 0.18 kg/tow is below the biomass target of 0.31 kg/tow but above the threshold reference point of 0.16 kg/tow (Figure B2). Smooth skate is thus not overfished. The 2003-2005 average of 0.18 kg/tow was above the 2002-2004 average of 0.17 kg/tow; therefore, overfishing is not occurring for smooth skate.

For clearnose skate, the 2003-2005 NEFSC autumn survey biomass index average of 0.63 kg/tow is above the biomass target and threshold reference points of 0.56 kg/tow and 0.28 kg/tow (Figure B2). Clearnose skate is thus not overfished. The 2003-2005 average of 0.63 kg/tow was less than 30% below the 2002-2004 average of 0.75 kg/tow; therefore, overfishing is not occurring for clearnose skate.

For rosette skate, the 2003-2005 NEFSC autumn survey biomass index average of 0.049 kg/tow is above the biomass target and threshold reference points of 0.029 kg/tow and 0.015 kg/tow (Figure B2). Rosette skate is thus not overfished. The 2003-2005 average of 0.049 kg/tow was above the 2002-2004 average of 0.045 kg/tow; therefore, overfishing is not occurring for rosette skate.

**Summary Status Table (Note: For all species except little skate, the most recent data used were from the 2005 NEFSC Autumn Survey):**

| Species | Series | Btarget | Bthresh | Current | Status | Critical Percent | Current Percent | Status |
|---|---|---|---|---|---|---|---|---|
| Winter | GOM-MA Off Autumn 67-98 | 6.46 | 3.23 | 3.34 | Not Overfished | -20 | -22.9 | Overfishing |
| Little | GOM-MA All Spring 82-99 | 6.54 | 3.27 | 4.59 | Not Overfished | -20 | -15.9 | No Overfishing |
| Barndoor | GOM-SNE Off Autumn 63-66 | 1.62 | 0.81 | 0.96 | Not Overfished | -30 | 9.8 | No Overfishing |
| Thorny | GOM-SNE Off Autumn 63-98 | 4.41 | 2.20 | 0.56 | Overfished | -20 | -11.2 | No Overfishing |
| Smooth | GOM-SNE Off Autumn 63-98 | 0.31 | 0.16 | 0.18 | Not Overfished | -30 | 3.7 | No Overfishing |
| Clearnose | MA All Autumn 75-98 | 0.56 | 0.28 | 0.63 | Not Overfished | -30 | -16.2 | No Overfishing |
| Rosette | MA Offshore Autumn 67-98 | 0.029 | 0.015 | 0.049 | Not Overfished | -60 | 9.7 | No Overfishing |

**Forecast for 2007-2008:** No forecasts were made for any of the species in the skate complex.

## Landings and Status Table (weights in '000 mt): Skate complex

| Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | Max | Min | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Skate Complex** | | | | | | | | | | | | | | |
| Commercial landings | 14.2 | 10.9 | 13.8 | 11.7 | 13.4 | 13.1 | 13 | 15 | 16.1 | 13.9 | | 16.1[1] | 0.8[1] | 7.3[1] |
| Commercial discards[2] | 52.1 | 26.2 | 29.3 | 33.8 | 42.4 | 49.5 | 74.1 | 48.3 | 33.3 | 19.7 | | 87.2[3] | 19.7[3] | 49.2[3] |
| Recreational landings | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | <0.1 |
| Recreational discards[4] | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | | <0.1 | <0.1 | <0.1 |
| Total catch | 14.3 | 10.9 | 13.8 | 11.7 | 13.4 | 13.1 | 13 | 15 | 16.1 | 13.9 | | 16.1 | 6.7 | 12.1 |
| Total biomass index[5] | 11.3 | 5.6 | 7.0 | 12.1 | 11.0 | 10.5 | 9.9 | 10.0 | 7.9 | 6.3 | 8.1 | 25.3[6] | 3.6[6] | 10.9[6] |
| **Winter skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 2.28 | 2.46 | 3.75 | 5.09 | 4.38 | 3.89 | 5.60 | 3.39 | 4.03 | 2.61 | | 15.80[7] | 1.08[7] | 4.91[7] |
| SSB index[5] | 0.79 | 0.66 | 1.58 | 1.33 | 1.75 | 1.40 | 3.15 | 1.91 | 2.22 | 1.00 | | 12.28[7] | 0.15[7] | 2.75[7] |
| Recruitment index[8] | 0.12 | 0.17 | 0.17 | 0.24 | 0.25 | 0.18 | 0.10 | 0.06 | 0.13 | 0.21 | | 0.72[7] | 0.01[7] | 0.21[7] |
| **Little skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 7.57 | 2.71 | 7.47 | 9.98 | 8.60 | 6.84 | 6.44 | 6.49 | 7.22 | 3.24 | 3.32 | 9.98[9] | 2.71[9] | 5.56[9] |
| SSB index[5] | 4.55 | 1.60 | 3.63 | 5.08 | 4.42 | 4.78 | 4.86 | 4.40 | 4.34 | 2.45 | 2.47 | 5.08[9] | 1.60[9] | 3.25[9] |
| Recruitment index[8] | 3.55 | 1.35 | 3.67 | 4.87 | 4.66 | 2.09 | 1.98 | 2.89 | 3.46 | 0.84 | 1.09 | 4.87[9] | 0.83[9] | 2.33[9] |
| **Barndoor skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 0.04 | 0.10 | 0.09 | 0.30 | 0.29 | 0.54 | 0.78 | 0.55 | 1.29 | 1.04 | | 2.63[10] | 0.00[10] | 0.31[10] |
| SSB index[5] | 0.00 | 0.05 | 0.06 | 0.12 | 0.05 | 0.25 | 0.37 | 0.16 | 0.77 | 0.29 | | 0.80[10] | 0.00[10] | 0.09[10] |
| Recruitment index[8] | 0.00 | 0.00 | 0.01 | 0.02 | 0.01 | 0.03 | 0.07 | 0.04 | 0.03 | 0.09 | | 0.25[10] | 0.00[10] | 0.03[10] |
| **Thorny skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 0.81 | 0.85 | 0.65 | 0.48 | 0.83 | 0.33 | 0.44 | 0.74 | 0.71 | 0.22 | | 7.97[10] | 0.22[10] | 2.60[10] |
| SSB index[5] | 0.32 | 0.33 | 0.32 | 0.14 | 0.42 | 0.07 | 0.20 | 0.23 | 0.36 | 0.05 | | 5.16[10] | 0.05[10] | 1.39[10] |
| Recruitment index[8] | 0.07 | 0.05 | 0.02 | 0.03 | 0.05 | 0.04 | 0.05 | 0.10 | 0.05 | 0.04 | | 0.29[10] | 0.02[10] | 0.14[10] |
| **Smooth skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 0.18 | 0.23 | 0.03 | 0.07 | 0.15 | 0.29 | 0.11 | 0.19 | 0.21 | 0.13 | | 0.50[10] | 0.03[10] | 0.20[10] |
| SSB index[5] | 0.13 | 0.17 | 0.02 | 0.06 | 0.10 | 0.23 | 0.09 | 0.11 | 0.15 | 0.08 | | 0.30[10] | 0.02[10] | 0.13[10] |
| **Clearnose skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 0.43 | 0.61 | 1.12 | 1.05 | 1.03 | 1.61 | 0.89 | 0.66 | 0.71 | 0.52 | | 1.61[11] | 0.14[11] | 0.55[11] |
| SSB index[5] | 0.08 | 0.27 | 0.23 | 0.44 | 0.37 | 0.38 | 0.26 | 0.35 | 0.26 | 0.25 | | 0.44[11] | 0.00[11] | 0.15[11] |
| Recruitment index[8] | 0.04 | 0.08 | 0.14 | 0.09 | 0.06 | 0.08 | 0.17 | 0.14 | 0.10 | 0.05 | | 0.17[11] | 0.01[11] | 0.08[11] |
| **Rosette skate** | | | | | | | | | | | | | | |
| Total Biomass index[5] | 0.043 | 0.013 | 0.05 | 0.067 | 0.033 | 0.121 | 0.052 | 0.033 | 0.048 | 0.065 | | 0.121[7] | 0.001[7] | 0.029[7] |
| SSB index[5] | 0.029 | 0.009 | 0.051 | 0.055 | 0.028 | 0.129 | 0.034 | 0.032 | 0.043 | 0.057 | | 0.129[7] | 0.001[7] | 0.025[7] |

[1]Over period 1964-2005; [2]Commercial fishery discard mortality rate unknown; [3]Over period 1989-2005; [4]Assuming 15% recreational fishery release mortality. [5]NEFSC survey kg/tow; [6]Over period 1968-2006; [7]Over period 1967-2005; [8]NEFSC survey number/tow; [9]Over period 1982-2006; [10]Over period 1963-2005; [11]Over period 1975-2005

**Stock Distribution and Identification:** The seven species in the northeast skate complex are distributed from near the tide line to depths exceeding 700 m (383 fathoms) (Figure B3). The species are: little skate (*Leucoraja erinacea*), winter skate (*L. ocellata*), barndoor skate (*Dipturus laevis*), thorny skate (*Amblyraja radiata*), smooth skate (*Malacoraja senta*), clearnose skate (*Raja eglanteria*), and rosette skate (*L. garmani*). Off the Northeast coast of the United States, the center of distribution for little and winter skates is Georges Bank and Southern New England. Barndoor skates are found in the Gulf of Maine, on Georges Bank, and in Southern New England. Thorny and smooth skates occur in the Gulf of Maine. Clearnose and rosette skates have a more southern distribution, and are found primarily in Southern New England and the Chesapeake Bight. Skates are not known to undertake large-scale migrations, but they do move seasonally in response to changes in water temperature, moving offshore in summer and early autumn and returning inshore during winter and spring. Information on stock structure for all skate species is lacking.

**Catches:** The principal commercial fishing method in the directed skate fishery is otter trawling. Skates are frequently taken as bycatch during groundfish trawling and scallop dredge operations, and are discarded. Recreational and foreign landings are currently insignificant. Skates have

been reported in New England fishery landings since the late 1800s. Reported commercial fishery landings, primarily from off Rhode Island, however, did not exceed several hundred metric tons until the advent of distant-water fleets and the industrial fishery during the 1950s and 1960s. Skate landings reached 9,500 mt in 1969 primarily from the distant water fleet, but declined quickly during the 1970s, reaching 800 mt in 1981 (Figure B4). Landings have since increased, partly in response to demand for lobster bait, and more significantly, to the increased export market for skate wings. Landings are not reported by species, and over 99% of the landings are reported as "unclassified skates." Wings were likely taken from large-bodied skates (winter, thorny and barndoor), with winter and thorny skate known to be used for human consumption. Bait landings are presumed to be primarily from little skate, based on areas fished and known species distribution patterns. Landings increased to 12,900 mt in 1993 and then declined somewhat to 7,200 mt in 1995. Landings increased again and the 2004 reported commercial landings of 16,073 mt were the highest on record. Estimates of discards suggest they may be 2-4 times larger than the average landings. Commercial fishery discard mortality rates by species are unknown.

**Data and Assessment:** The skate complex was last assessed at SARC 30 in 1999. In the current assessment, conclusions about the status of the seven species in the northeast US region skate complex are based mainly on standardized NEFSC research trawl survey data collected during 1963-2006 (i.e., spring survey of 2006 was used, but not the fall survey of 2006).

**Biological Reference Points:** Biomass reference points (Figure B2) are based entirely on survey data because commercial catches are not available by species. For all species except barndoor, the $B_{msy}$ proxy ($B_{target}$) is estimated as the 75$^{th}$ percentile of the appropriate survey series for that species (see Summary Status Table). For barndoor skate, the $B_{msy}$ proxy is the average of the autumn survey biomass indices from a short period, 1963-1966. This period is used for barndoor skates because the survey captured few barndoor skates for a protracted period after these years. The stocks are declared to be overfished when the three-year moving average of the NMFS trawl survey index (mean weight per tow) is less than one half of the 75$^{th}$ percentile of mean weight per tow of the reference survey series for that species ($B_{threshold}$).

The overfishing definition is based on changes in survey biomass indices. In any year, if the three-year moving average of the survey biomass index for a skate species declines by more than a critical percentage from the previous year's moving average, then fishing mortality is assumed to be greater than $F_{msy}$ and overfishing is assumed to be occurring for that skate species. The critical percentages for each species are given in the Summary Status Table.

**Fishing Mortality:** (Estimates made by the Working Group were not accepted by the SARC.)

**Total Biomass:** During the late 1960s and 1970s, indices of winter skate biomass from the NEFSC autumn surveys were stable, but below the time series mean (Figure B5). Winter skate indices increased to the time series mean by 1980, and then reached a peak during the mid 1980s. Winter skates indices began to decline in the late 1980s. Current NEFSC indices of winter skate biomass are below the time series mean (4.91 kg/tow) and are about 20% of the peak observed during the mid 1980s.

Little skate spring survey indices reached a peak in 1999, and declined thereafter (Figure B7).

Indices of barndoor skate biomass from the NEFSC autumn surveys were at the highest values during 1960s, and then declined to 0 fish per tow during the early 1980s (Figure B8). Since 1990, autumn survey indices have increased steadily.

NEFSC autumn survey biomass indices for thorny skate have declined continuously over the last 40 years (Figure B10), and the 2005 index was a record low.

Indices of smooth skate biomass from the NEFSC autumn survey were highest during the late 1970s (Figure B12). NEFSC survey indices declined during the 1980s, before stabilizing during the early 1990s at about 25% of the values of the 1970s.

NEFSC autumn survey biomass indices for clearnose skate increased from the mid-1980s through 2000 and have since declined to about the time series average (0.55 kg/tow) (Figure B13).

Indices of rosette skate biomass from the NEFSC autumn surveys peaked during 1980 and 1981 and then declined through 1986 (Figure B2). NEFSC biomass indices then increased and peaked again in 2001. Recent indices have been above the time series average (0.029 kg/tow).

**Spawning Stock Biomass:** Winter skate SSB generally follows the autumn total biomass index (Figure B5). Low values in the 1970s were followed by increases in the 1980s. SSB declined in the late 1980s and early 1990s, increased slightly until 2002, and has since declined again and is currently at a relatively low value.

Little skate SSB has been fairly stable through the time series with slightly higher values from 1999-2004 than in the 1980s and early 1990s (Figure B7).

The pattern in barndoor skate SSB indices is much the same as that of total biomass, with high values in the early 1960s, low to zero values in the 1970s and 1980s, and then a consistent increase in the 1990s and 2000s (Figure B8).

The decline in thorny skate SSB is similar but more pronounced than for total biomass (Figure B10).

Smooth skate SSB indices are very variable over the time series (Figure B12).

Clearnose skate SSB has generally increased over the survey time period (Figure B13).

Rosette skate SSB has been variable but has generally increased.

**Recruitment:** Winter skate recruitment indices (number/tow between 34 and 39 cm) were variable at a low level in the 1970s, increased to a higher level in the 1980s, but have since stabilized at a lower level (Figure B5).

Little skate recruitment indices (number/tow between 38 and 42 cm) peaked in 1999 and 2000, and have since been at a somewhat lower level. The 2005 and 2006 values are among the lowest in the time series (Figure B7).

Barndoor skate recruitment indices (number/tow between 55 and 69 cm) were high in the early 1960s, declined to low levels through the 1970s and the 1980s, but have since increased to about half the level in the 1960s (Figure B8).

Thorny skate recruitment indices (number/tow between 25 and 35 cm) were relatively high although variable from 1963 to 1990, but have since declined to very low levels (Figure B10).

Clearnose skate recruitment indices (number/tow between 42 and 50 cm) have been relatively stable through the time series with some high values in recent years (Figure B13).

For several skate species, time-lagged recruitment indices are positively related to spawning stock biomass indices (Figures B6, B9, B11 and B14).

**Special Comments:** Species composition and size structure of landings are unknown. Although discard rates are imprecisely known (and likely underestimated) and discard mortality rates are unknown, the absolute level of discards is probably high relative to the landings (1-3 times). A lack of information on the stock structure of the species in the skate complex has increased uncertainty about historical trends in abundance and recommendations of appropriate biological reference points.

Compared to other fishes, large species of skates have slow growth, late maturity and low fecundity, making them vulnerable to overfishing.

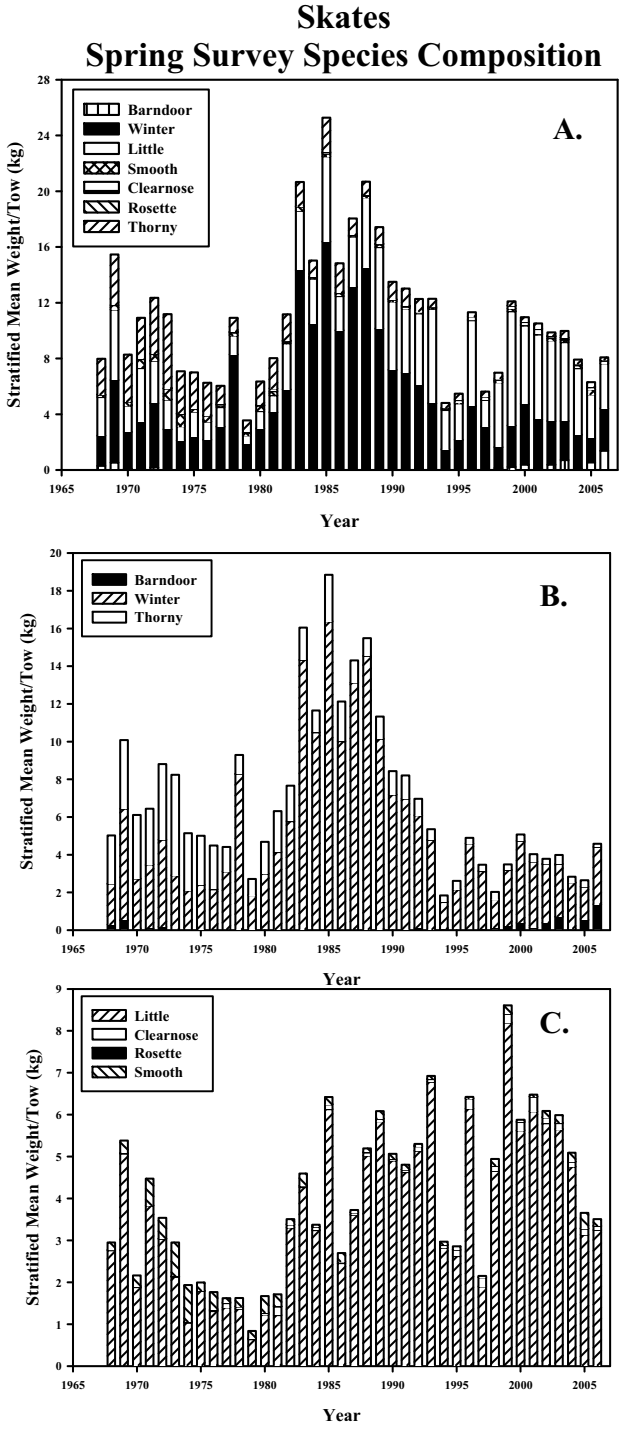
(The Working Group proposed new BRPs but they were not accepted by the SARC.)

**Sources of Information:**

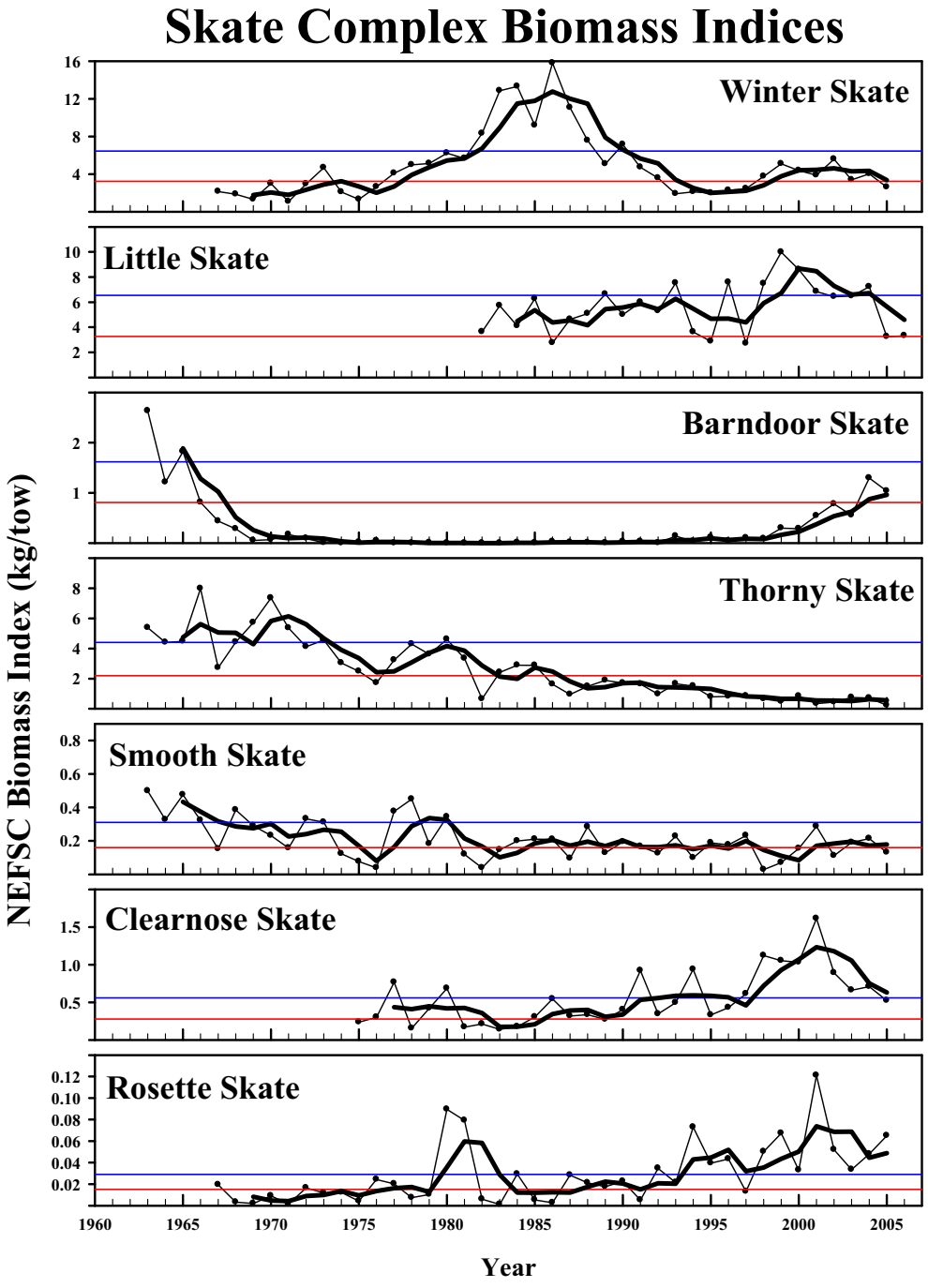
Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull., U.S. Fish. Wildl. Serv. 74(53), 577 p.

Northeast Fisheries Science Center (NEFSC). 2000. 30th Northeast Regional Stock Assessment Workshop (30th SAW), Stock Assessment Review Committee (SARC) Consensus Summary of Assessments. NEFSC Ref. Doc. 00-03, 477 p.

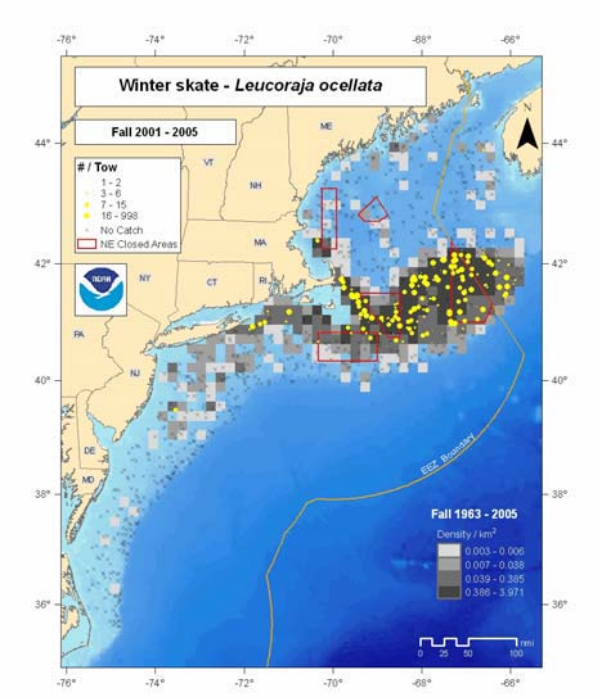
Northeast Fisheries Science Center (NEFSC). (in prep.) 44th Northeast Regional Stock Assessment Workshop (43rd SAW): 43rd SAW assessment report. NEFSC Ref. Doc.



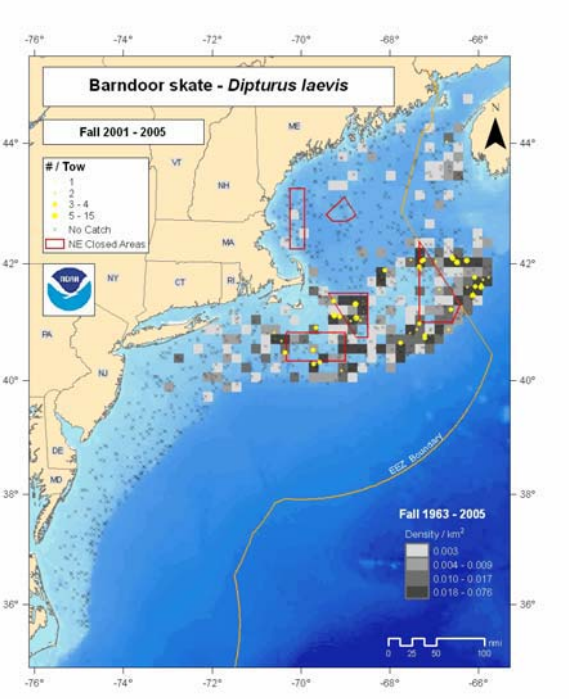

**B1.** Species composition of skates from the spring survey. Panel A shows the composition of all species, panel B shows the composition of large species (>100 cm maximum length), and panel C shows the composition of the small species (maximum length < 100cm).



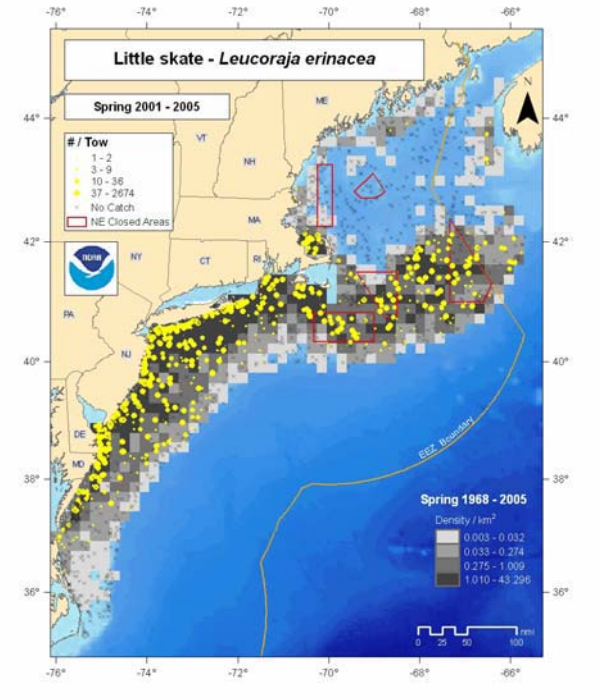

**B2.** NEFSC survey biomass indices (kg/tow). Thin lines with dots are annual indices. Thick lines are 3-year moving averages. Thin horizontal lines are the **current/existing** biomass targets and thresholds.



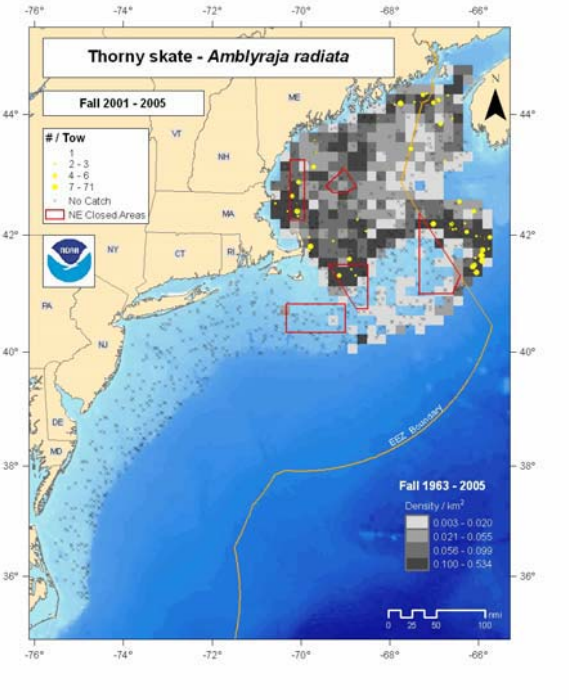

Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.




Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

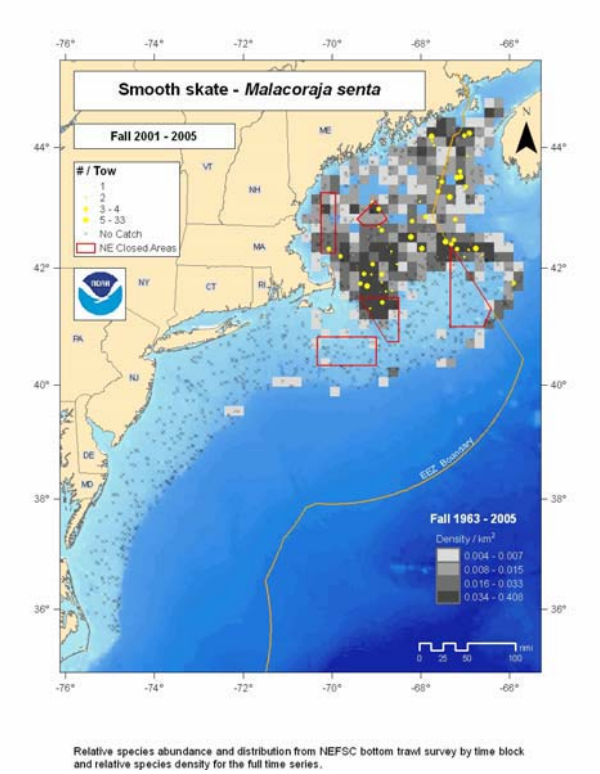



Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

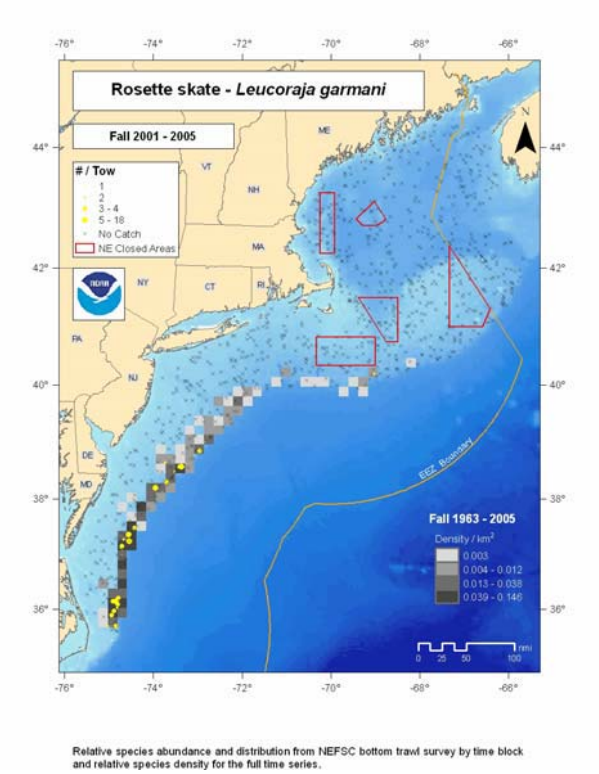



Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

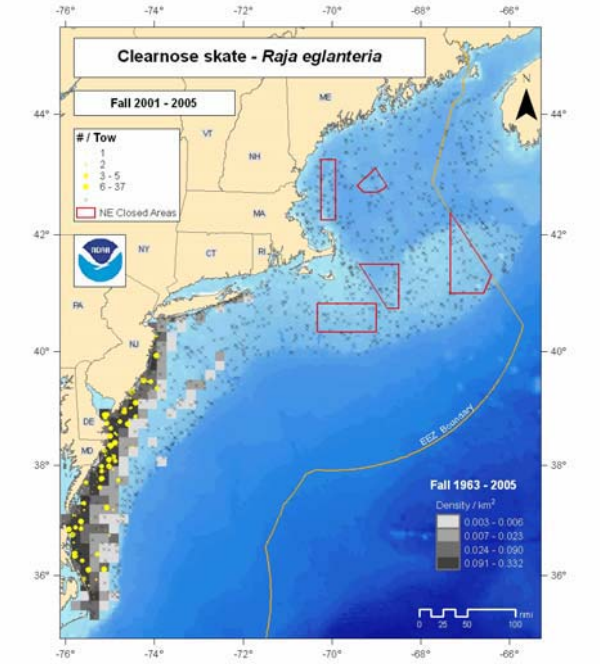
**B3.** Skate distributions, by species.




Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

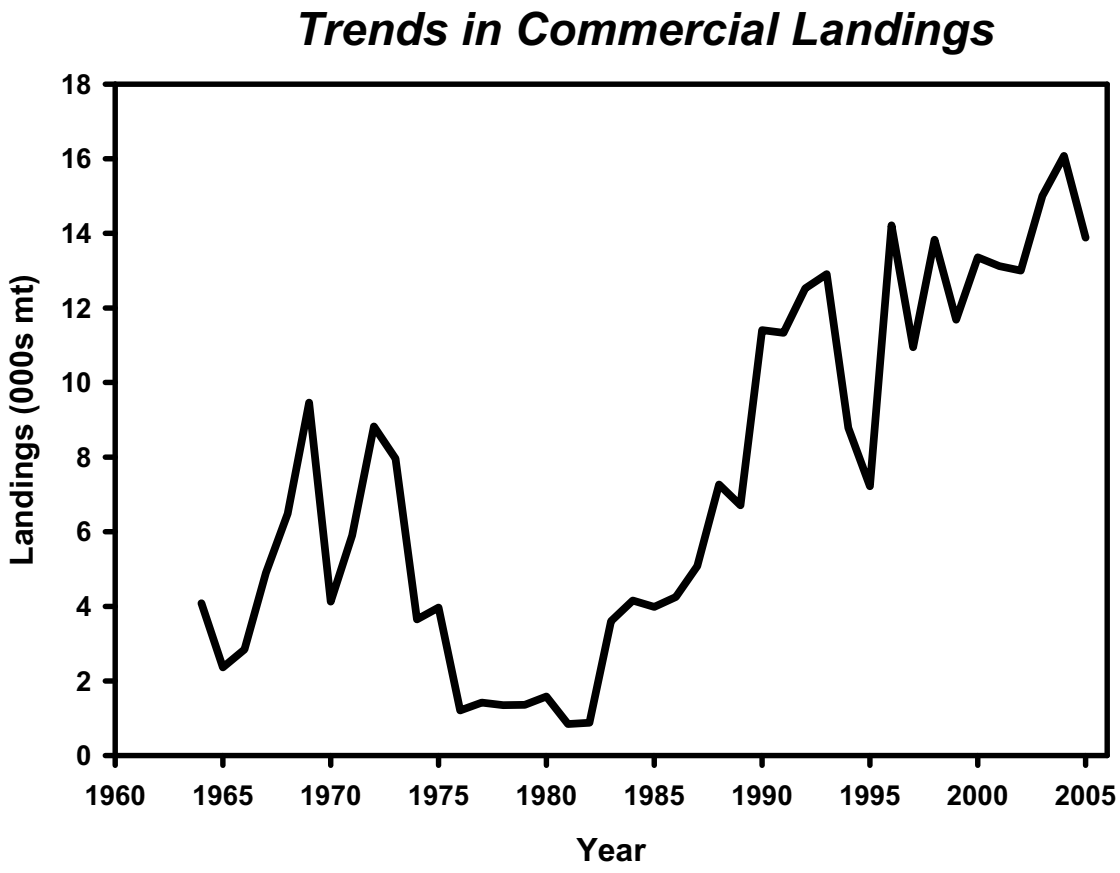



Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

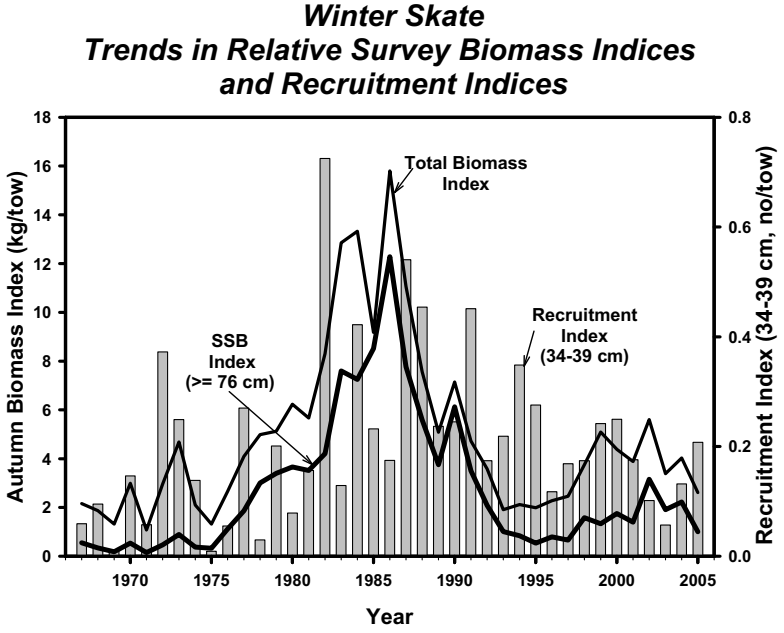



Relative species abundance and distribution from NEFSC bottom trawl survey by time block and relative species density for the full time series.

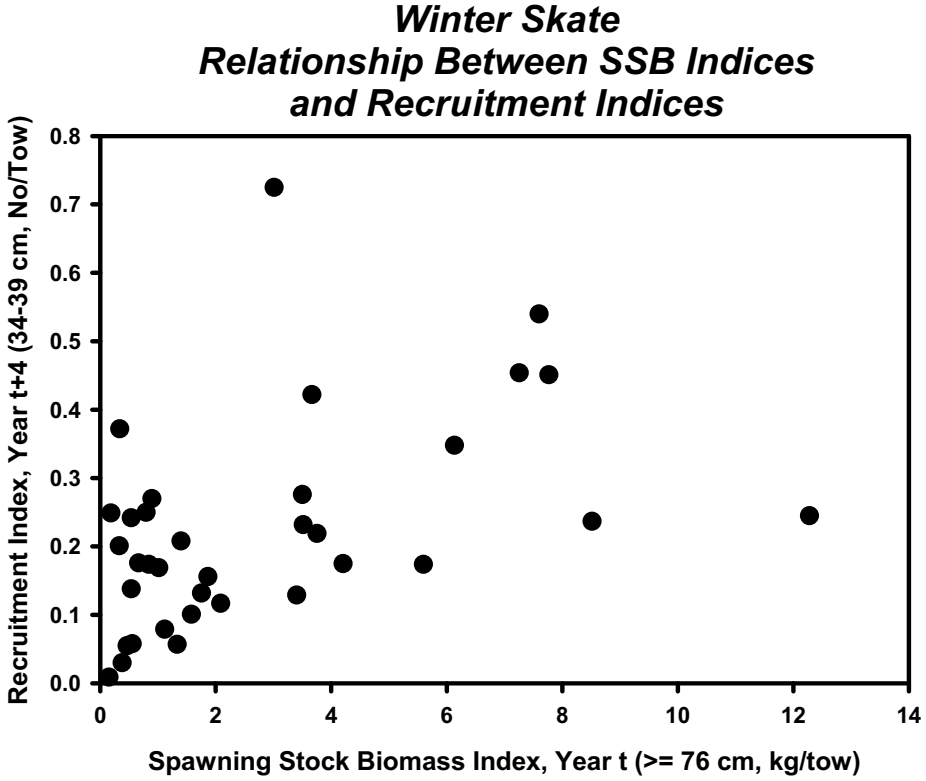
B3. (cont).



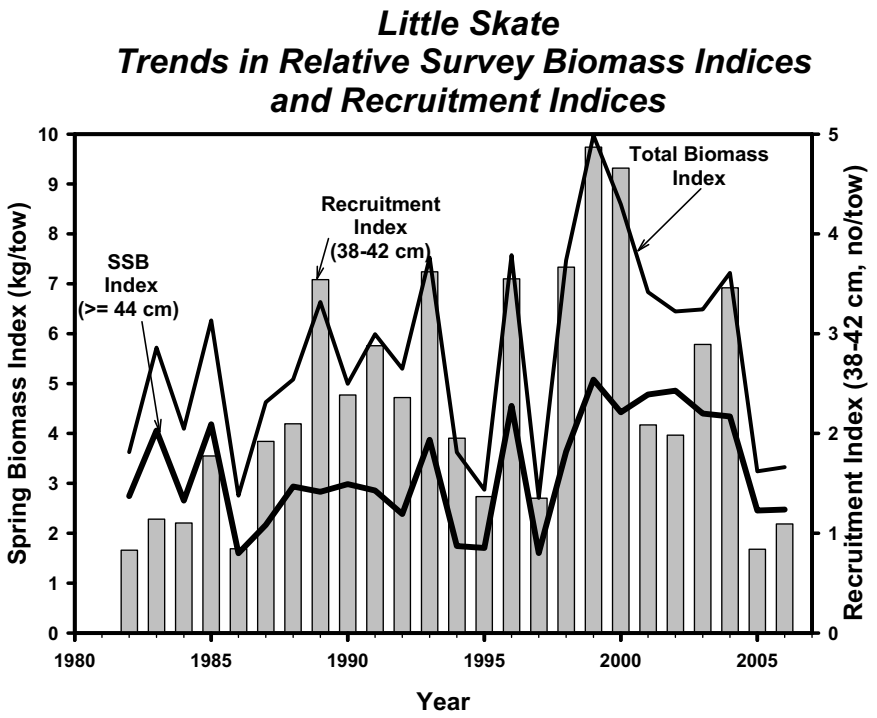

**B4.** Trends in commercial landings (000s mt) for all skate species combined, 1964-2005.



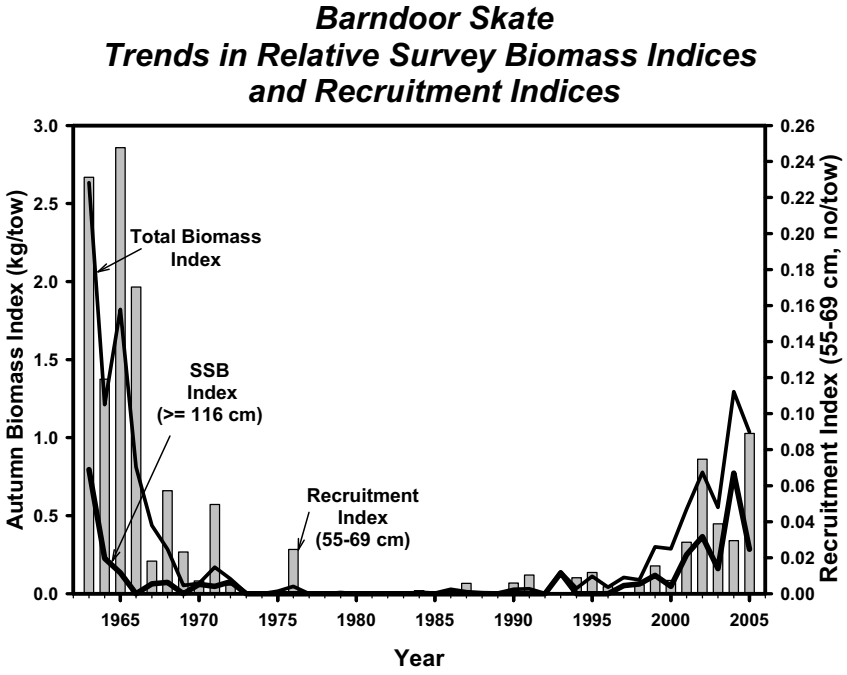

**B5**. Trends in autumn relative survey total biomass indices, spawning stock biomass indices (>= 76 cm) and recruitment indices (number/tow between 34 and 39 cm) for winter skate from 1967-2005.



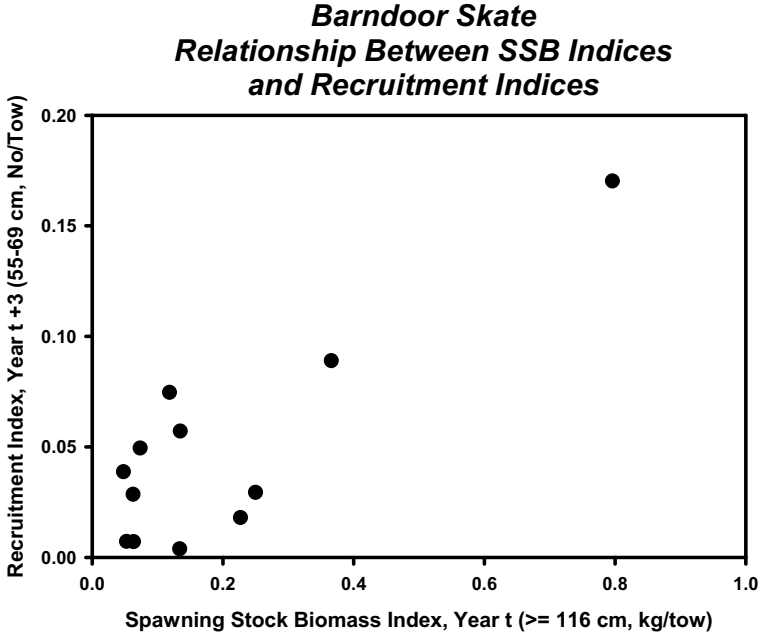

**B6**. Relationship between spawning stock biomass indices (>= 76 cm) and recruitment indices (number/tow, 34-39 cm) for winter skate. The time lag between SSB and recruitment accounts for the assumed age 3 at recruitment plus one year for hatching time.



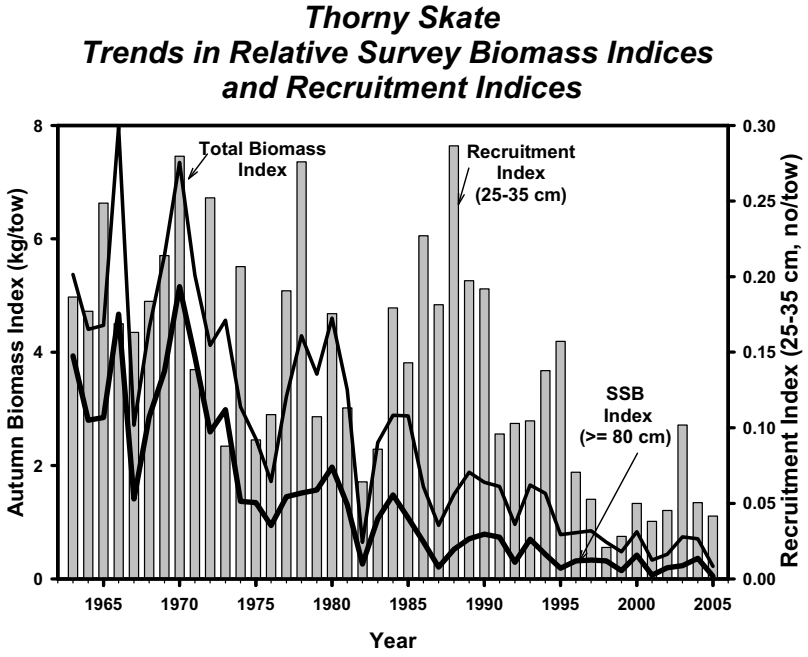

**B7**. Trends in spring relative survey total biomass indices, spawning stock biomass indices (>= 44 cm) and recruitment indices (number/tow between 38 and 42 cm) for little skate from 1982-2006.



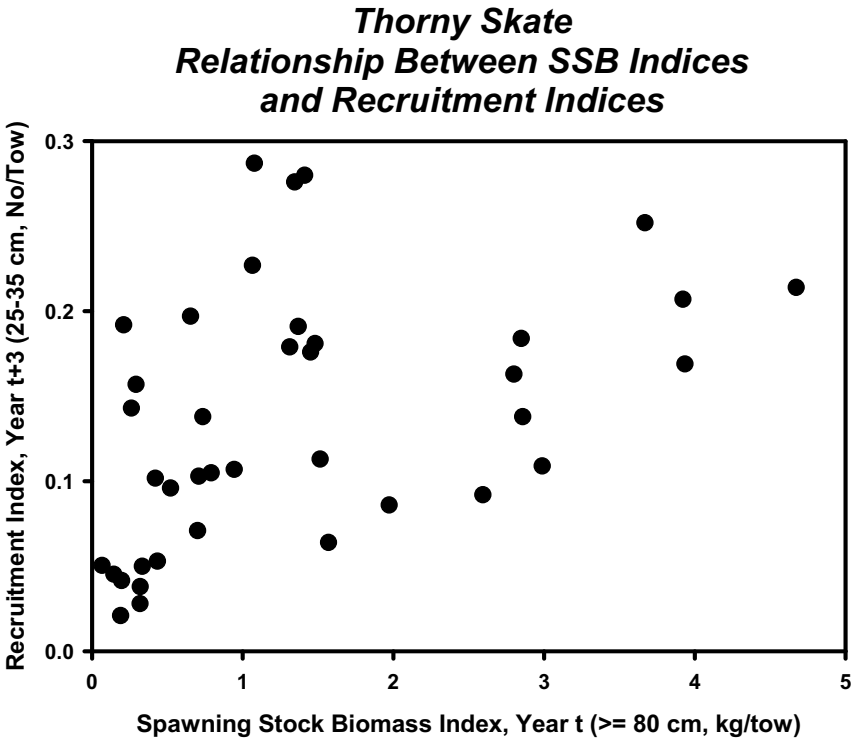

**B8**. Trends in autumn relative survey total biomass indices, spawning stock biomass indices (>= 116 cm) and recruitment indices (number/tow between 55 and 69 cm) for barndoor skate from 1963-2005.



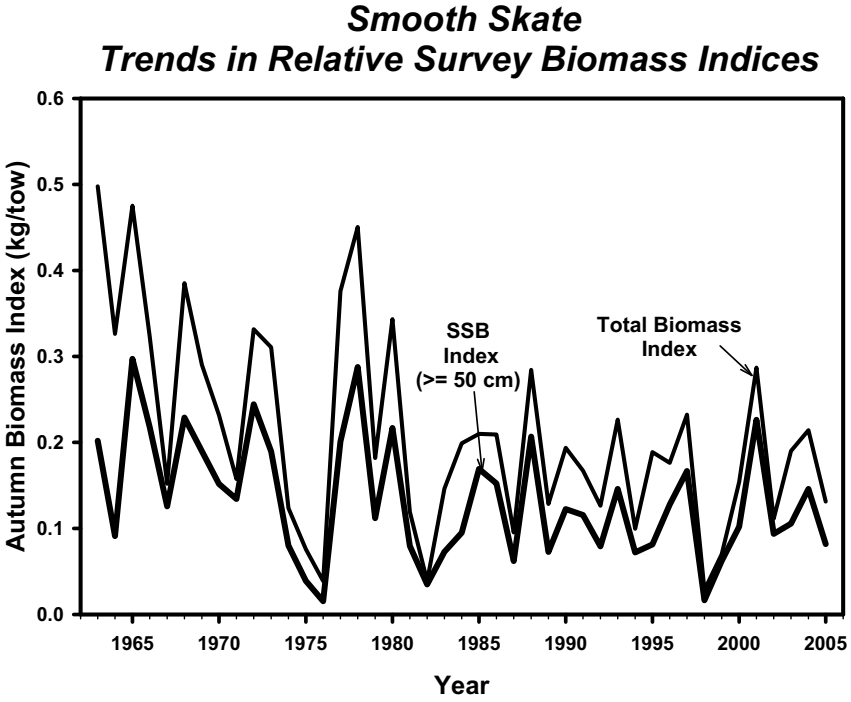

**B9**. Relationship between spawning stock biomass indices (>= 116 cm) and recruitment indices (number/tow, 55-69 cm) for barndoor skate. The time lag between SSB and recruitment accounts for the assumed age 2 at recruitment plus one year for hatching time.



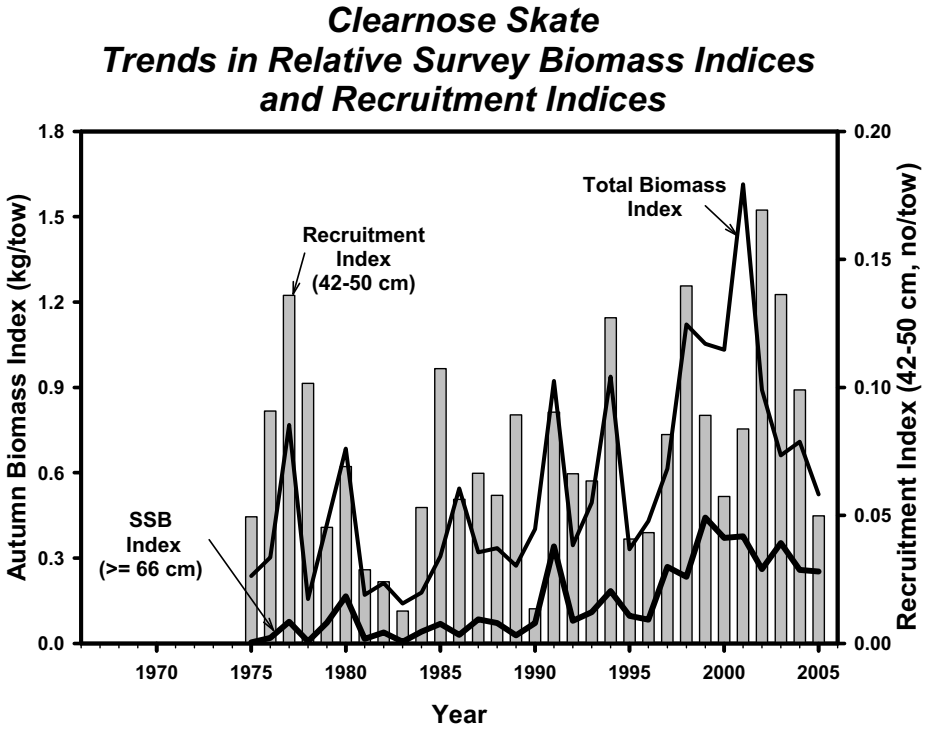

**B10**. Trends in autumn relative survey total biomass indices, spawning stock biomass indices (>= 80 cm) and recruitment indices (number/tow between 25 and 35 cm) for thorny skate from 1963-2005.



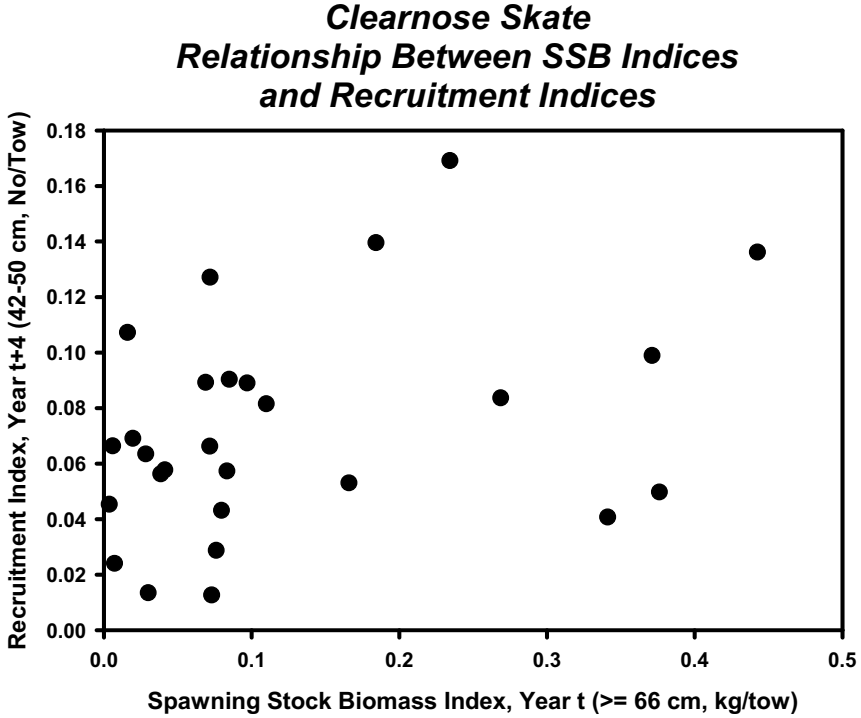

**B11**. Relationship between spawning stock biomass indices (>= 80 cm) and recruitment indices (number/tow, 25-35 cm) for thorny skate. The time lag between SSB and recruitment accounts for the assumed age 2 at recruitment plus one year for hatching time.




**B12**. Trends in autumn relative survey total biomass indices and spawning stock biomass indices (>= 50 cm) for smooth skate from 1963-2005.




**B13**. Trends in autumn relative survey total biomass indices, spawning stock biomass indices (>= 66 cm) and recruitment indices (number/tow between 42 and 50 cm) for clearnose skate from 1975-2005.




**B14**. Relationship between spawning stock biomass indices (>= 66 cm) and recruitment indices (number/tow, 42-50 cm) for clearnose skate. The time lag between SSB and recruitment accounts for the assumed age 3 at recruitment plus one year for hatching time.