**C. Georges Bank Yellowtail Flounder** by C.M. Legault

**1.0 Background**

The Georges Bank yellowtail flounder stock has exhibited a strong retrospective problem with updated spawning stock biomass estimated lower in successive assessments and fully recruited F estimated higher: 2001 SSB was 39,000 t and fully recruited F was 0.13 in the 2002 assessment (NEFSC 2002b; Stone 2002), 2001 SSB was 16,000 t and fully recruited F was 0.48 in the 2003 assessment (Stone and Legault 2003), and 2001 SSB was 9,000 t and fully recruited F was 0.88 in the 2004 assessment (Legault and Stone 2004). A benchmark assessment was conducted in 2005 that revised US landings and discards, revised Canadian landings and surveys, and added Canadian discards. This report reflects the 2005 Transboundary Resource Assessment Committee (TRAC) assessment (Stone and Legault 2005).

**2.0 Assessment Data**

2.1 US Landings
U.S. landings were prorated as described in Cadrin et al. (1998; Table C1; Figure C1). US landings from Georges Bank in 2004 were the largest since 1983 due to a Special Access Program in Closed Area II. Sampling intensity of landings in 2002-2004 increased relative to that in 2001 (Table C2). Both the large and small categories were sampled in both halves of the year. Landings at length by half year and market category were used with half year specific age-length keys to estimate landings at age and mean weights at age.

2.2 US Discards
US discarded catch for trawl gear in years 2002-2004 was estimated from observer information on discard to kept ratios by half-year. US discarded catch for scallop dredge gear in years 2001-2004 was estimated from a regression between annual discarded yellowtail flounder and landed scallop meat weight (Stone and Legault 2005). US discards were approximately 9% of the US catch in years 2002-2004 (Table C1; Figure C1). Discards at age and associated mean weights at age were estimated from sea sampled lengths and pooled commercial, observer, and survey age-length keys.

2.3 Canadian Landings
Canadian landings in 2004 were well below previous levels and the allowed quota for that fishery (0.1 kt caught vs quota of 1.9 kt; Table C1; Figure C1). Length frequencies collected by Canadian samplers were used with sex specific age-length keys provided from US landings to generate the Canadian landings by age in 2002. In 2003 and 2004, scale samples from Canadian landings were aged by the US readers and these age-length keys used directly for these landings.

2.4 Canadian Discards
During the 2005 benchmark assessment, yellowtail flounder discards from the Canadian scallop fleet were estimated for the entire time series and used in the stock assessment for the first time (Stone and Legault 2005). Inclusion of this catch did not cause a large change in the assessment results because the magnitude is relatively constant throughout the time series used in the assessment, 1973 onward (Table C1; Figure C1). Discards at length were estimated from ogives

of relative selectivity compared to research survey catches at length and converted to ages using age-length keys from US and Canada commercial landings and observers by quarter.

## 2.5 Total Catch at Age

Total catch at age was formed by adding the US landings, US discards, Canadian landings, and Canadian discards for use in virtual population analysis (Table C3a). Average weight at age was computed as the catch weighted average of the weights at age from these four sources (Table C3b).

## 2.6 Research Vessel Survey Indices

Survey abundance and biomass indices are reported in Table C4. Estimates from research vessel surveys are from valid tows on Georges Bank (NEFSC offshore strata 13-21; Canadian strata 5Z1-5Z4; NEFSC scallop strata 54, 55, 58-72, 74) standardized according to net, vessel, and door changes (Legault and Stone 2004). The three surveys of biomass show a similar pattern of rapid increase from lows in the early to mid 1990s to highs in the early 2000s followed by a decline in the most recent years (Figure C2).

## 3.0 Assessment Results

### 3.1 Age-Based Analysis

The 2005 benchmark assessment could not select a single formulation for Georges Bank yellowtail flounder VPA stock assessment. Instead, the previously used "Base Case VPA" (same formulation as GARM; NEFSC 2002b) was used along with a "Major Change VPA" which extended the ages from 6+ to 12, split the survey time series in 1995, and allowed for power functions relating survey abundance at age to model estimates. These two formulations were thought to bracket the possible status of the stock. The updated Base Case VPA calibration of Georges Bank yellowtail flounder is summarized in Table C4 and compared to the Major Change VPA in Figure C3. Results indicate that the fully recruited fishing mortality rate never dropped below Fmsy (0.25) and is currently above 1 in 2004. Spawning biomass increased considerably since 1995, but is well below values previously estimated, and recruitment is moderate. However, the Base Case analysis continues to show a strong retrospective pattern of underestimating F and overestimating SSB in the terminal year, as seen in previous assessments (Figure C4). The Major Change VPA does not show a retrospective pattern, updated estimates are both above and below previously estimated values. Bootstrap analysis indicates that abundance was estimated with moderate precision (CV=32-40%). These results cannot be directly compared to the results presented in the TRAC using Canadian software (TRAC 2005) because the Canadian VPA results are all bias-corrected while these are not. However, trends are similar between the results from US and Canadian software.

### 3.2 Stock Status

Proxies for MSY reference points were derived from yield and SSB per recruit analyses and the assumption of constant recruitment (NEFSC 2002a). Long-term average recruitment is 53.8 million at age-1.
MSY = 12,900 t
SSBmsy = 58,800 t.
Fmsy = 0.25 fully recruited (derived from F40%)

Therefore, according to both VPA results, the stock is overfished and overfishing is occurring, e.g. SSB2004=15,700 t (Base Case VPA) or 8,500 t (Major Change VPA) < 29,400 t = ½ 58,800 and F2004=1.19 (Base Case VPA) or 1.75 (Major Change VPA) > 0.25 = Fmsy.

3.3 Comparison with GARM Projections
In the GARM report (NEFSC 2002b), projections were presented for spawning stock biomass under an Frebuild=0.22 in years 2003 through 2009 which would achieve a 50% probability of Bmsy in 2009. Due to the strong retrospective pattern in the Base Case VPA, the SSB in years 2002 through 2004 are now estimated to be well below the GARM projections (Figure C5).

**4.0 Sources of Uncertainty**

- Retrospective patterns continue in the VPA for this assessment. Updated VPAs may indicate higher F and lower SSB in 2004 than the values reported here.
- The two formulations of VPA produce different numerical results, but both point to the stock being overfished and that overfishing is occurring.
- Estimates of prorated landings and discard ratios are based on preliminary logbook data and are subject to change.

**5.0 GARM Panel Comments**

The possible causes of the retrospective problem were discussed.   Although several hypotheses were posed to explain the conflict between the relatively low catch and few old fish in the fishery and surveys, none of the hypotheses are supported by information on the fishery or resource.  A net movement of a large portion of the adult population is not supported by the ongoing tagging study.  Underestimation of catch would have to be approximately 3,000 t to cause the observed retrospective differences. Natural mortality would have to be more than four times the rate assumed in the assessment, but fish size at age actually increased in recent years.  The survey catchability would have had to double in 1995 to cause the pattern.  Reduced vulnerability of old fish to the fishery is also not supported by information on gear selectivity, geographic comparisons of age and size distributions, nor observations of fish movement in and out of the closed areas.

Projection Advice - The group agreed that both the 'base case' results with retrospective patterns, and 'major change' results with no retrospective patterns should be considered to assess stock status and evaluate management alternatives using mean weights, partial recruitment and recruitment options documented in the 2005 TRAC document. Mean weights and partial recruitments are calculated as the average of the most recent three years. Recruitment for 2005 is estimated as the geometric mean of the most recent 10 years for each bootstrap. Recruitment for years 2006 – 2009 is generated from two stage resampling of cumulative distribution function for recruitment below and above 5 thousand t, as was used in the setting of the biomass reference point.

**6.0 References**

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TRAC (Transboundary Resource Assessment Committee). 2005. Georges Bank yellowtail flounder Status Report 2005/03.

Table C1. Catch of Georges Bank yellowtail flounder (thousand t).

| Year | US Landings | US Discards | Canada Landings | Canada Discards | Foreign | Total Catch |
|------|------|------|------|------|------|------|
| 1963 | 11.0 | 5.6 | 0.0 | 0.0 | 0.1 | 16.7 |
| 1964 | 14.9 | 4.9 | 0.0 | 0.0 | 0.0 | 19.8 |
| 1965 | 14.2 | 4.4 | 0.0 | 0.0 | 0.8 | 19.4 |
| 1966 | 11.3 | 2.1 | 0.0 | 0.0 | 0.3 | 13.7 |
| 1967 | 8.4 | 5.5 | 0.0 | 0.0 | 1.4 | 15.3 |
| 1968 | 12.8 | 3.6 | 0.1 | 0.0 | 1.8 | 18.3 |
| 1969 | 15.9 | 2.6 | 0.3 | 0.0 | 2.4 | 21.3 |
| 1970 | 15.5 | 5.5 | 0.1 | 0.0 | 0.3 | 21.4 |
| 1971 | 11.9 | 3.1 | 0.1 | 0.0 | 0.5 | 15.6 |
| 1972 | 14.2 | 1.2 | 0.0 | 0.5 | 2.2 | 18.0 |
| 1973 | 15.9 | 0.4 | 0.0 | 0.4 | 0.3 | 17.0 |
| 1974 | 14.6 | 1.0 | 0.0 | 0.6 | 1.0 | 17.2 |
| 1975 | 13.2 | 2.7 | 0.0 | 0.7 | 0.1 | 16.7 |
| 1976 | 11.3 | 3.0 | 0.0 | 0.6 | 0.0 | 15.0 |
| 1977 | 9.4 | 0.6 | 0.0 | 0.6 | 0.0 | 10.6 |
| 1978 | 4.5 | 1.7 | 0.1 | 0.7 | 0.0 | 6.9 |
| 1979 | 5.5 | 0.7 | 0.0 | 0.7 | 0.0 | 6.9 |
| 1980 | 6.5 | 0.4 | 0.1 | 0.6 | 0.0 | 7.5 |
| 1981 | 6.2 | 0.1 | 0.0 | 0.7 | 0.0 | 7.0 |
| 1982 | 10.6 | 1.4 | 0.0 | 0.5 | 0.0 | 12.5 |
| 1983 | 11.4 | 0.1 | 0.1 | 0.5 | 0.0 | 12.0 |
| 1984 | 5.8 | 0.0 | 0.0 | 0.5 | 0.0 | 6.3 |
| 1985 | 2.5 | 0.0 | 0.0 | 0.7 | 0.0 | 3.3 |
| 1986 | 3.0 | 0.0 | 0.1 | 0.4 | 0.0 | 3.5 |
| 1987 | 2.7 | 0.2 | 0.1 | 0.5 | 0.0 | 3.6 |
| 1988 | 1.9 | 0.3 | 0.1 | 0.6 | 0.0 | 2.8 |
| 1989 | 1.1 | 0.1 | 0.0 | 0.5 | 0.0 | 1.8 |
| 1990 | 2.8 | 0.8 | 0.0 | 0.5 | 0.0 | 4.1 |
| 1991 | 1.8 | 0.2 | 0.1 | 0.5 | 0.0 | 2.6 |
| 1992 | 2.9 | 1.9 | 0.1 | 0.5 | 0.0 | 5.3 |
| 1993 | 2.1 | 1.1 | 0.7 | 0.4 | 0.0 | 4.3 |
| 1994 | 1.6 | 0.2 | 2.1 | 0.4 | 0.0 | 4.3 |
| 1995 | 0.4 | 0.0 | 0.5 | 0.3 | 0.0 | 1.2 |
| 1996 | 0.8 | 0.1 | 0.5 | 0.4 | 0.0 | 1.7 |
| 1997 | 1.0 | 0.1 | 0.8 | 0.4 | 0.0 | 2.3 |
| 1998 | 1.8 | 0.1 | 1.2 | 0.7 | 0.0 | 3.8 |
| 1999 | 2.0 | 0.5 | 2.0 | 0.6 | 0.0 | 5.0 |
| 2000 | 3.7 | 0.4 | 2.9 | 0.4 | 0.0 | 7.4 |
| 2001 | 3.8 | 0.3 | 2.9 | 0.8 | 0.0 | 7.9 |
| 2002 | 2.5 | 0.2 | 2.6 | 0.5 | 0.0 | 5.9 |
| 2003 | 3.3 | 0.4 | 2.1 | 0.8 | 0.0 | 6.6 |
| 2004 | 6.2 | 0.5 | 0.1 | 0.4 | 0.0 | 7.3 |

Table C2. Sampling history of the Georges Bank yellowtail flounder fishery.

| | | | US Length Samples | | | | Canada | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Half | Trips | Small | Large | Ages | Landings (t) | Trips | Lengths | Landings (t) |
| 2000 | 1 | 8 | 94 | 782 | 200 | 2223 | 5 | 1120 | 92 |
| | 2 | 12 | 598 | 1288 | 405 | 1455 | 53 | 13048 | 2767 |
| | All | 11 | 692 | 2070 | 605 | 3678 | 58 | 14168 | 2859 |
| 2001 | 1 | 15 | 696 | 1055 | 433 | 2779 | 3 | 647 | 37 |
| | 2 | 15 | 1073 | 576 | 381 | 989 | 30 | 6824 | 2876 |
| | All | 30 | 1769 | 1631 | 814 | 3768 | 33 | 7471 | 2913 |
| 2002 | 1 | 15 | 469 | 880 | 313 | 2110 | 1 | 250 | 2 |
| | 2 | 11 | 333 | 788 | 239 | 421 | 25 | 5222 | 2640 |
| | All | 26 | 802 | 1668 | 552 | 2531 | 26 | 5472 | 2642 |
| 2003 | 1 | 27 | 1169 | 1603 | 640 | 2092 | 5 | 1066 | 365 |
| | 2 | 19 | 822 | 1040 | 476 | 1251 | 22 | 4877 | 1705 |
| | All | 46 | 1991 | 2643 | 1116 | 3343 | 27 | 5943 | 2070 |
| 2004 | 1 | 48 | 2113 | 3049 | 1113 | 3075 | 2 | 500 | 33 |
| | 2 | 26 | 1237 | 1565 | 579 | 3132 | 6 | 1509 | 63 |
| | All | 74 | 3350 | 4614 | 1692 | 6207 | 8 | 2009 | 96 |

Table C3a. Total catch (thousands) at age of Georges Bank yellowtail flounder.

| Year | Age 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1973 | 359 | 5175 | 13565 | 9473 | 3815 | 1285 | 283 | 55 | 23 | 4 | 0 | 0 |
| 1974 | 2368 | 9500 | 8294 | 7658 | 3643 | 878 | 464 | 106 | 71 | 0 | 0 | 0 |
| 1975 | 4636 | 26394 | 7375 | 3540 | 2175 | 708 | 327 | 132 | 26 | 14 | 0 | 0 |
| 1976 | 635 | 31938 | 5502 | 1426 | 574 | 453 | 304 | 95 | 54 | 11 | 2 | 0 |
| 1977 | 378 | 9094 | 10567 | 1846 | 419 | 231 | 134 | 82 | 37 | 10 | 0 | 0 |
| 1978 | 9962 | 3542 | 4580 | 1914 | 540 | 120 | 45 | 16 | 17 | 7 | 6 | 0 |
| 1979 | 321 | 10517 | 3789 | 1432 | 623 | 167 | 95 | 31 | 27 | 1 | 3 | 0 |
| 1980 | 318 | 3994 | 9685 | 1538 | 352 | 96 | 5 | 11 | 1 | 0 | 0 | 0 |
| 1981 | 107 | 1097 | 5963 | 4920 | 854 | 135 | 5 | 2 | 3 | 0 | 0 | 0 |
| 1982 | 2164 | 18091 | 7480 | 3401 | 1095 | 68 | 20 | 7 | 0 | 0 | 0 | 0 |
| 1983 | 703 | 7998 | 16661 | 2476 | 680 | 122 | 13 | 16 | 4 | 0 | 0 | 0 |
| 1984 | 514 | 2018 | 4535 | 5043 | 1796 | 294 | 47 | 39 | 0 | 0 | 0 | 0 |
| 1985 | 970 | 4374 | 1058 | 818 | 517 | 73 | 8 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 179 | 6402 | 1127 | 389 | 204 | 80 | 17 | 15 | 0 | 1 | 0 | 0 |
| 1987 | 156 | 3284 | 3137 | 983 | 192 | 48 | 38 | 26 | 25 | 0 | 0 | 0 |
| 1988 | 499 | 3003 | 1544 | 846 | 227 | 24 | 26 | 3 | 0 | 0 | 0 | 0 |
| 1989 | 190 | 2175 | 1121 | 428 | 110 | 18 | 12 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 231 | 2114 | 6996 | 978 | 140 | 21 | 6 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 663 | 147 | 1491 | 3011 | 383 | 67 | 4 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 2414 | 9167 | 2971 | 1473 | 603 | 33 | 7 | 1 | 1 | 0 | 0 | 0 |
| 1993 | 5233 | 1386 | 3327 | 2326 | 411 | 84 | 5 | 1 | 0 | 0 | 0 | 0 |
| 1994 | 59 | 1432 | 6631 | 1856 | 568 | 95 | 23 | 1 | 0 | 0 | 0 | 0 |
| 1995 | 62 | 233 | 1428 | 986 | 211 | 17 | 23 | 4 | 2 | 0 | 0 | 0 |
| 1996 | 54 | 566 | 1922 | 941 | 234 | 11 | 9 | 3 | 0 | 0 | 0 | 0 |
| 1997 | 60 | 745 | 1502 | 1827 | 442 | 36 | 55 | 11 | 5 | 0 | 0 | 0 |
| 1998 | 64 | 1496 | 3224 | 2134 | 782 | 143 | 26 | 3 | 0 | 2 | 0 | 0 |
| 1999 | 37 | 3694 | 3583 | 1731 | 743 | 180 | 34 | 1 | 1 | 0 | 0 | 0 |
| 2000 | 155 | 3840 | 5985 | 3120 | 832 | 340 | 43 | 36 | 1 | 0 | 0 | 0 |
| 2001 | 284 | 3065 | 7622 | 2824 | 1093 | 293 | 254 | 23 | 9 | 0 | 0 | 0 |
| 2002 | 256 | 4437 | 3854 | 1845 | 670 | 263 | 113 | 62 | 11 | 5 | 0 | 0 |
| 2003 | 160 | 3818 | 4965 | 2297 | 777 | 328 | 213 | 93 | 39 | 15 | 1 | 0 |
| 2004 | 78 | 1336 | 3491 | 4093 | 2088 | 919 | 429 | 85 | 73 | 20 | 2 | 0 |

Table C3b. Total weight (kg) at age of Georges Bank yellowtail flounder.

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|------|---|---|---|---|---|---|---|---|---|----|----|----|
| | | | | | Age | | | | | | | |
| 1973 | 0.101 | 0.348 | 0.462 | 0.527 | 0.603 | 0.690 | 1.063 | 1.131 | 1.275 | 1.389 | 1.170 | |
| 1974 | 0.115 | 0.344 | 0.496 | 0.607 | 0.678 | 0.723 | 0.904 | 1.245 | 1.090 | | 1.496 | 1.496 |
| 1975 | 0.113 | 0.316 | 0.489 | 0.554 | 0.619 | 0.690 | 0.691 | 0.654 | 1.052 | 0.812 | | |
| 1976 | 0.108 | 0.312 | 0.544 | 0.635 | 0.744 | 0.813 | 0.854 | 0.881 | 1.132 | 1.363 | 1.923 | |
| 1977 | 0.116 | 0.342 | 0.524 | 0.633 | 0.780 | 0.860 | 1.026 | 1.008 | 0.866 | 0.913 | | |
| 1978 | 0.102 | 0.314 | 0.510 | 0.690 | 0.803 | 0.903 | 0.947 | 1.008 | 1.227 | 1.581 | 0.916 | |
| 1979 | 0.114 | 0.329 | 0.462 | 0.656 | 0.736 | 0.844 | 0.995 | 0.906 | 1.357 | 1.734 | 1.911 | |
| 1980 | 0.101 | 0.322 | 0.493 | 0.656 | 0.816 | 1.048 | 1.208 | 1.206 | 1.239 | | | |
| 1981 | 0.122 | 0.335 | 0.489 | 0.604 | 0.707 | 0.821 | 0.844 | 1.599 | 1.104 | | | |
| 1982 | 0.115 | 0.301 | 0.485 | 0.650 | 0.754 | 1.065 | 1.037 | 1.361 | | | | |
| 1983 | 0.140 | 0.296 | 0.441 | 0.607 | 0.740 | 0.964 | 1.005 | 1.304 | 1.239 | | | |
| 1984 | 0.162 | 0.239 | 0.379 | 0.500 | 0.647 | 0.743 | 0.944 | 1.032 | | | | |
| 1985 | 0.181 | 0.361 | 0.505 | 0.642 | 0.729 | 0.808 | 0.728 | | | | | |
| 1986 | 0.181 | 0.341 | 0.540 | 0.674 | 0.854 | 0.976 | 0.950 | 1.250 | | 1.686 | | |
| 1987 | 0.121 | 0.324 | 0.524 | 0.680 | 0.784 | 0.993 | 0.838 | 0.771 | 0.809 | | | |
| 1988 | 0.103 | 0.328 | 0.557 | 0.696 | 0.844 | 1.042 | 0.865 | 1.385 | | | | |
| 1989 | 0.100 | 0.327 | 0.520 | 0.720 | 0.866 | 0.970 | 1.172 | 1.128 | | | | |
| 1990 | 0.105 | 0.290 | 0.395 | 0.585 | 0.693 | 0.787 | 1.057 | | | | | |
| 1991 | 0.121 | 0.237 | 0.369 | 0.486 | 0.723 | 0.850 | 1.306 | | | | | |
| 1992 | 0.101 | 0.293 | 0.365 | 0.526 | 0.651 | 1.098 | 1.125 | 1.303 | 1.303 | | | |
| 1993 | 0.100 | 0.285 | 0.379 | 0.501 | 0.564 | 0.843 | 1.130 | 1.044 | | | | |
| 1994 | 0.195 | 0.255 | 0.348 | 0.469 | 0.620 | 0.810 | 0.723 | 1.257 | | | | |
| 1995 | 0.167 | 0.246 | 0.352 | 0.463 | 0.584 | 0.766 | 0.805 | 0.532 | 0.810 | | | |
| 1996 | 0.140 | 0.292 | 0.412 | 0.563 | 0.721 | 0.916 | 1.062 | 1.287 | | | | |
| 1997 | 0.206 | 0.319 | 0.421 | 0.537 | 0.690 | 0.837 | 0.878 | 1.184 | 1.126 | | | |
| 1998 | 0.184 | 0.325 | 0.447 | 0.543 | 0.690 | 0.903 | 0.932 | 1.195 | | 1.473 | | |
| 1999 | 0.190 | 0.369 | 0.503 | 0.638 | 0.756 | 0.900 | 1.030 | 1.496 | 1.822 | | | |
| 2000 | 0.220 | 0.379 | 0.481 | 0.613 | 0.762 | 0.915 | 1.020 | 0.996 | 1.229 | | | |
| 2001 | 0.225 | 0.343 | 0.456 | 0.624 | 0.808 | 1.013 | 1.023 | 1.272 | 1.483 | | | |
| 2002 | 0.263 | 0.382 | 0.489 | 0.668 | 0.829 | 0.983 | 1.062 | 1.282 | 1.389 | 1.433 | | |
| 2003 | 0.226 | 0.360 | 0.477 | 0.652 | 0.830 | 0.945 | 1.033 | 1.148 | 1.273 | 1.432 | 1.708 | |
| 2004 | 0.194 | 0.292 | 0.436 | 0.581 | 0.723 | 0.884 | 1.001 | 1.206 | 1.207 | 1.306 | 1.421 | |

Table C4a. NEFSC Spring survey indices of Georges Bank yellowtail abundance and biomass.

Stratified Mean Number per Tow at Age

**NEFSC Spring Survey**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | kg/tow |
|------|---|---|---|---|---|---|---|---|---|----|----|----|--------|
| 1968 | 0.149 | 3.364 | 3.579 | 0.316 | 0.084 | 0.160 | 0.127 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.813 |
| 1969 | 1.015 | 9.406 | 11.119 | 3.096 | 1.423 | 0.454 | 0.188 | 0.057 | 0.000 | 0.000 | 0.000 | 0.000 | 11.170 |
| 1970 | 0.093 | 4.485 | 6.030 | 2.422 | 0.570 | 0.121 | 0.190 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 5.312 |
| 1971 | 0.791 | 3.335 | 4.620 | 3.754 | 0.759 | 0.227 | 0.050 | 0.010 | 0.000 | 0.019 | 0.000 | 0.000 | 4.607 |
| 1972 | 0.138 | 7.136 | 7.198 | 3.514 | 1.094 | 0.046 | 0.122 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 6.450 |
| 1973 | 1.931 | 3.266 | 2.368 | 1.063 | 0.410 | 0.173 | 0.023 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 | 2.938 |
| 1974 | 0.316 | 2.224 | 1.842 | 1.256 | 0.346 | 0.187 | 0.085 | 0.000 | 0.000 | 0.000 | 0.009 | 0.000 | 2.719 |
| 1975 | 0.420 | 2.939 | 0.860 | 0.298 | 0.208 | 0.068 | 0.000 | 0.013 | 0.000 | 0.000 | 0.000 | 0.000 | 1.676 |
| 1976 | 1.034 | 4.368 | 1.247 | 0.311 | 0.196 | 0.026 | 0.048 | 0.019 | 0.018 | 0.000 | 0.000 | 0.000 | 2.273 |
| 1977 | 0.000 | 0.671 | 1.125 | 0.384 | 0.074 | 0.013 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.999 |
| 1978 | 0.936 | 0.798 | 0.507 | 0.219 | 0.026 | 0.000 | 0.008 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.742 |
| 1979 | 0.279 | 1.933 | 0.385 | 0.328 | 0.059 | 0.046 | 0.041 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.227 |
| 1980 | 0.057 | 4.644 | 5.761 | 0.473 | 0.057 | 0.037 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 4.456 |
| 1981 | 0.012 | 1.027 | 1.779 | 0.721 | 0.205 | 0.061 | 0.000 | 0.026 | 0.000 | 0.000 | 0.000 | 0.001 | 1.960 |
| 1982 | 0.045 | 3.742 | 1.122 | 1.016 | 0.455 | 0.065 | 0.000 | 0.026 | 0.000 | 0.000 | 0.000 | 0.000 | 2.500 |
| 1983 | 0.000 | 1.865 | 2.728 | 0.531 | 0.123 | 0.092 | 0.061 | 0.092 | 0.000 | 0.000 | 0.000 | 0.000 | 2.642 |
| 1984 | 0.000 | 0.093 | 0.809 | 0.885 | 0.834 | 0.244 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.646 |
| 1985 | 0.110 | 2.198 | 0.262 | 0.282 | 0.148 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.988 |
| 1986 | 0.027 | 1.806 | 0.291 | 0.056 | 0.137 | 0.055 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.847 |
| 1987 | 0.000 | 0.128 | 0.112 | 0.133 | 0.053 | 0.055 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.329 |
| 1988 | 0.078 | 0.275 | 0.366 | 0.242 | 0.199 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.566 |
| 1989 | 0.047 | 0.424 | 0.740 | 0.290 | 0.061 | 0.022 | 0.022 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.729 |
| 1990 | 0.000 | 0.065 | 1.108 | 0.393 | 0.139 | 0.012 | 0.045 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.699 |
| 1991 | 0.435 | 0.000 | 0.254 | 0.675 | 0.274 | 0.020 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.631 |
| 1992 | 0.000 | 2.010 | 1.945 | 0.598 | 0.189 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.566 |
| 1993 | 0.046 | 0.290 | 0.500 | 0.317 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.482 |
| 1994 | 0.000 | 0.621 | 0.638 | 0.357 | 0.145 | 0.043 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.660 |
| 1995 | 0.040 | 1.180 | 4.810 | 1.490 | 0.640 | 0.010 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.579 |
| 1996 | 0.030 | 0.990 | 2.630 | 2.700 | 0.610 | 0.060 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.853 |
| 1997 | 0.019 | 1.169 | 3.733 | 4.081 | 0.703 | 0.134 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 4.359 |
| 1998 | 0.000 | 2.081 | 1.053 | 1.157 | 0.759 | 0.323 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.324 |
| 1999 | 0.050 | 4.746 | 10.820 | 2.720 | 1.623 | 0.426 | 0.329 | 0.000 | 0.024 | 0.000 | 0.000 | 0.000 | 9.307 |
| 2000 | 0.183 | 4.819 | 7.666 | 2.914 | 0.813 | 0.422 | 0.102 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 6.696 |
| 2001 | 0.000 | 2.315 | 6.563 | 2.411 | 0.483 | 0.352 | 0.101 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 5.008 |
| 2002 | 0.188 | 2.412 | 12.333 | 4.078 | 1.742 | 0.378 | 0.408 | 0.086 | 0.000 | 0.000 | 0.000 | 0.000 | 9.566 |
| 2003 | 0.202 | 4.370 | 6.764 | 2.876 | 0.442 | 0.128 | 0.536 | 0.198 | 0.000 | 0.000 | 0.000 | 0.000 | 6.719 |
| 2004 | 0.049 | 0.986 | 2.178 | 0.680 | 0.283 | 0.110 | 0.052 | 0.082 | 0.000 | 0.000 | 0.000 | 0.000 | 1.887 |
| 2005 | 0.000 | 2.013 | 5.080 | 2.403 | 0.270 | 0.037 | 0.052 | 0.025 | 0.000 | 0.000 | 0.000 | 0.000 | 3.401 |

Table C4b. NEFSC Fall survey indices of Georges Bank yellowtail abundance and biomass.

Stratified Mean Number per Tow at Age

**NEFSC Fall Survey**

| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12+ | kg/tow |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1963 | 14.722 | 7.896 | 11.226 | 1.858 | 0.495 | 0.281 | 0.034 | 0.164 | 0.069 | 0.000 | 0.000 | 0.000 | 12.791 |
| 1964 | 1.721 | 9.723 | 7.370 | 5.998 | 2.690 | 0.383 | 0.095 | 0.028 | 0.000 | 0.000 | 0.000 | 0.000 | 13.625 |
| 1965 | 1.138 | 5.579 | 5.466 | 3.860 | 1.803 | 0.162 | 0.284 | 0.038 | 0.000 | 0.000 | 0.000 | 0.000 | 9.104 |
| 1966 | 8.772 | 4.776 | 2.070 | 0.837 | 0.092 | 0.051 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.989 |
| 1967 | 9.137 | 9.313 | 2.699 | 1.007 | 0.309 | 0.076 | 0.061 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 7.577 |
| 1968 | 11.782 | 11.946 | 5.758 | 0.766 | 0.944 | 0.059 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 10.535 |
| 1969 | 8.106 | 10.381 | 5.855 | 1.662 | 0.553 | 0.149 | 0.182 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 9.278 |
| 1970 | 4.610 | 5.133 | 3.144 | 1.952 | 0.451 | 0.063 | 0.017 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 4.978 |
| 1971 | 3.627 | 6.949 | 4.904 | 2.248 | 0.551 | 0.234 | 0.024 | 0.024 | 0.000 | 0.000 | 0.000 | 0.000 | 6.362 |
| 1972 | 2.424 | 6.525 | 4.824 | 2.095 | 0.672 | 0.279 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 6.328 |
| 1973 | 2.494 | 5.497 | 5.104 | 2.944 | 1.216 | 0.416 | 0.171 | 0.000 | 0.031 | 0.000 | 0.000 | 0.000 | 6.600 |
| 1974 | 4.623 | 2.854 | 1.524 | 1.060 | 0.460 | 0.249 | 0.131 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.734 |
| 1975 | 4.625 | 2.511 | 0.877 | 0.572 | 0.334 | 0.033 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.031 | 2.365 |
| 1976 | 0.336 | 1.929 | 0.475 | 0.117 | 0.122 | 0.033 | 0.000 | 0.033 | 0.033 | 0.000 | 0.000 | 0.000 | 1.533 |
| 1977 | 0.928 | 2.161 | 1.649 | 0.618 | 0.113 | 0.056 | 0.036 | 0.016 | 0.000 | 0.000 | 0.000 | 0.000 | 2.828 |
| 1978 | 4.729 | 1.272 | 0.773 | 0.406 | 0.139 | 0.011 | 0.000 | 0.024 | 0.000 | 0.000 | 0.000 | 0.000 | 2.383 |
| 1979 | 1.312 | 1.999 | 0.316 | 0.122 | 0.138 | 0.038 | 0.064 | 0.000 | 0.007 | 0.000 | 0.000 | 0.000 | 1.520 |
| 1980 | 0.761 | 5.086 | 6.050 | 0.678 | 0.217 | 0.162 | 0.006 | 0.000 | 0.033 | 0.000 | 0.000 | 0.000 | 6.722 |
| 1981 | 1.584 | 2.333 | 1.630 | 0.500 | 0.121 | 0.083 | 0.013 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.621 |
| 1982 | 2.424 | 2.185 | 1.590 | 0.423 | 0.089 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.271 |
| 1983 | 0.109 | 2.284 | 1.914 | 0.473 | 0.068 | 0.012 | 0.000 | 0.000 | 0.038 | 0.000 | 0.000 | 0.000 | 2.131 |
| 1984 | 0.661 | 0.400 | 0.306 | 2.428 | 0.090 | 0.029 | 0.000 | 0.018 | 0.000 | 0.000 | 0.000 | 0.000 | 0.593 |
| 1985 | 1.350 | 0.560 | 0.160 | 0.040 | 0.080 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.709 |
| 1986 | 0.280 | 1.110 | 0.350 | 0.070 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.820 |
| 1987 | 0.113 | 0.390 | 0.396 | 0.053 | 0.079 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.509 |
| 1988 | 0.019 | 0.213 | 0.102 | 0.031 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.171 |
| 1989 | 0.248 | 1.992 | 0.774 | 0.069 | 0.066 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.977 |
| 1990 | 0.000 | 0.326 | 1.517 | 0.280 | 0.014 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.725 |
| 1991 | 2.100 | 0.275 | 0.439 | 0.358 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.730 |
| 1992 | 0.151 | 0.396 | 0.712 | 0.162 | 0.144 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.576 |
| 1993 | 0.842 | 0.136 | 0.587 | 0.536 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.545 |
| 1994 | 1.200 | 0.220 | 0.980 | 0.710 | 0.260 | 0.030 | 0.030 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.897 |
| 1995 | 0.280 | 0.120 | 0.350 | 0.280 | 0.050 | 0.010 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.354 |
| 1996 | 0.140 | 0.350 | 1.870 | 0.450 | 0.070 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.303 |
| 1997 | 1.392 | 0.533 | 3.442 | 2.090 | 1.071 | 0.082 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 3.781 |
| 1998 | 1.900 | 4.817 | 4.202 | 1.190 | 0.298 | 0.055 | 0.019 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 4.347 |
| 1999 | 3.090 | 8.423 | 5.727 | 1.432 | 1.436 | 0.260 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 7.973 |
| 2000 | 0.629 | 1.697 | 4.814 | 2.421 | 0.948 | 0.800 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 5.838 |
| 2001 | 3.518 | 6.268 | 8.091 | 2.601 | 1.718 | 0.714 | 1.334 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 11.553 |
| 2002 | 2.093 | 5.751 | 2.127 | 0.594 | 0.277 | 0.000 | 0.027 | 0.027 | 0.000 | 0.000 | 0.000 | 0.000 | 3.760 |
| 2003 | 1.102 | 5.006 | 2.809 | 0.565 | 0.100 | 0.092 | 0.075 | 0.025 | 0.000 | 0.000 | 0.000 | 0.000 | 4.039 |
| 2004 | 0.876 | 5.508 | 5.010 | 2.106 | 0.924 | 0.176 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 5.117 |

Table C4c. Canadian survey indices of Georges Bank yellowtail abundance and biomass.

| | Stratified Mean Number per Tow at Age | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Canadian Survey** | | | | | Age | | | | | | | | |
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | kg/tow |
| 1987 | 0.120 | 0.988 | 2.002 | 0.638 | 0.121 | 0.000 | 0.020 | 0.024 | 0.000 | 0.000 | 0.000 | 0.000 | 1.250 |
| 1988 | 0.000 | 1.588 | 1.292 | 0.760 | 0.295 | 0.009 | 0.018 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.235 |
| 1989 | 0.114 | 0.941 | 0.583 | 0.364 | 0.088 | 0.014 | 0.023 | 0.007 | 0.000 | 0.000 | 0.000 | 0.000 | 0.471 |
| 1990 | 0.000 | 2.359 | 3.383 | 1.064 | 0.322 | 0.008 | 0.016 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.513 |
| 1991 | 0.024 | 0.858 | 1.531 | 3.230 | 0.725 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.758 |
| 1992 | 0.055 | 10.745 | 3.969 | 1.034 | 0.301 | 0.010 | 0.000 | 0.018 | 0.009 | 0.000 | 0.000 | 0.000 | 2.475 |
| 1993 | 0.079 | 2.245 | 3.265 | 4.406 | 1.635 | 0.046 | 0.011 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.642 |
| 1994 | 0.000 | 6.056 | 3.464 | 3.006 | 0.781 | 0.133 | 0.030 | 0.044 | 0.000 | 0.000 | 0.000 | 0.000 | 2.753 |
| 1995 | 0.210 | 1.190 | 4.281 | 2.554 | 0.785 | 0.050 | 0.036 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 2.027 |
| 1996 | 0.446 | 6.655 | 8.579 | 6.615 | 1.010 | 0.092 | 0.017 | 0.033 | 0.000 | 0.000 | 0.000 | 0.000 | 5.303 |
| 1997 | 0.022 | 9.781 | 14.674 | 17.957 | 4.324 | 0.532 | 0.110 | 0.089 | 0.000 | 0.000 | 0.000 | 0.000 | 13.293 |
| 1998 | 0.893 | 3.179 | 4.891 | 4.504 | 2.021 | 0.459 | 0.033 | 0.012 | 0.000 | 0.020 | 0.000 | 0.000 | 4.293 |
| 1999 | 0.159 | 11.841 | 27.242 | 7.949 | 7.296 | 2.214 | 0.335 | 0.037 | 0.000 | 0.000 | 0.000 | 0.000 | 17.666 |
| 2000 | 0.011 | 9.468 | 32.902 | 17.802 | 5.539 | 2.955 | 0.324 | 0.217 | 0.000 | 0.000 | 0.000 | 0.000 | 19.949 |
| 2001 | 0.291 | 15.176 | 47.131 | 13.353 | 3.696 | 1.954 | 0.897 | 0.100 | 0.000 | 0.000 | 0.000 | 0.000 | 22.158 |
| 2002 | 0.088 | 9.667 | 33.733 | 11.269 | 5.970 | 1.540 | 0.955 | 0.383 | 0.079 | 0.000 | 0.000 | 0.000 | 20.699 |
| 2003 | 0.066 | 6.759 | 27.355 | 13.450 | 3.570 | 0.862 | 0.618 | 0.250 | 0.117 | 0.044 | 0.000 | 0.000 | 16.249 |
| 2004 | 0.033 | 3.599 | 16.260 | 9.205 | 2.273 | 0.627 | 0.234 | 0.463 | 0.092 | 0.000 | 0.000 | 0.000 | 9.000 |
| 2005 | 0.600 | 1.602 | 27.959 | 20.564 | 5.696 | 1.041 | 0.397 | 0.099 | 0.014 | 0.014 | 0.000 | 0.000 | 13.357 |

Table C4d. NEFSC scallop survey indices of Georges Bank yellowtail abundance.

| Scallop Survey | |
|---|---|
| Year | Age-1 |
| 1982 | 0.313 |
| 1983 | 0.140 |
| 1984 | 0.233 |
| 1985 | 0.549 |
| 1986 | 0.103 |
| 1987 | 0.047 |
| 1988 | 0.116 |
| 1989 | 0.195 |
| 1990 | 0.100 |
| 1991 | 2.117 |
| 1992 | 0.167 |
| 1993 | 1.129 |
| 1994 | 1.503 |
| 1995 | 0.609 |
| 1996 | 0.508 |
| 1997 | 1.062 |
| 1998 | 1.872 |
| 1999 | 1.038 |
| 2000 | 0.912 |
| 2001 | 0.789 |
| 2002 | 1.005 |
| 2003 | 0.880 |
| 2004 | 0.330 |

# Table C5a. Estimates of stock size from Base Case VPA.

```
JAN-1 Population Numbers


    AGE      1973       1974       1975       1976       1977
  _____

     1      29386.     52186.     70632.     24731.     17280.
     2      24172.     23735.     40589.     53646.     19675.
     3      29516.     15136.     10932.      9853.     15555.
     4      17301.     12051.      5010.      2427.      3172.
     5       6967.      5733.      3078.       977.       720.
     6       3013.      2392.      1708.      1562.       851.
  ================================================================
  Total    110355.    111234.    131951.     93196.     57252.

    AGE      1978       1979       1980       1981       1982
  _____

     1      54436.     25511.     24034.     62999.     22847.
     2      13807.     35603.     20596.     19390.     51482.
     3       7988.      8122.     19711.     13269.     14885.
     4       3391.      2468.      3267.      7498.      5537.
     5        957.      1074.       748.      1302.      1783.
     6        374.       560.       240.       221.       156.
  ================================================================
  Total     80952.     73337.     68595.    104679.     96691.

    AGE      1983       1984       1985       1986       1987
  _____

     1       6582.     10842.     16748.      8473.      9199.
     2      16754.      4755.      8413.     12837.      6775.
     3      25939.      6579.      2089.      2990.      4801.
     4       5517.      6473.      1379.       767.      1439.
     5       1515.      2305.       871.       402.       281.
     6        345.       486.       137.       223.       201.
  ================================================================
  Total     56653.     31441.     29637.     25692.     22696.

    AGE      1988       1989       1990       1991       1992
  _____

     1      22878.      9732.     11542.     22787.     18342.
     2       7390.     18280.      7796.      9241.     18058.
     3       2617.      3364.     13006.      4485.      7433.
     4       1153.       771.      1749.      4419.      2335.
     5        309.       198.       250.       562.       956.
     6         72.        54.        47.       104.        67.
  ================================================================
  Total     34419.     32399.     34390.     41598.     47191.

    AGE      1993       1994       1995       1996       1997
  _____

     1      13961.     10669.     11145.     13220.     18556.
     2      12842.      6744.      8682.      9069.     10775.
     3       6613.      9265.      4234.      6898.      6914.
     4       3427.      2447.      1735.      2186.      3922.
     5        606.       749.       371.       544.       949.
     6        134.       157.        83.        53.       230.
  ================================================================
  Total     37583.     30031.     26249.     31969.     41344.
```

JAN-1 Population Numbers

| AGE | 1998 | 1999 | 2000 | 2001 | 2002 |
|-----|------|------|------|------|------|
| 1 | 24156. | 26119. | 22406. | 25986. | 39088. |
| 2 | 15138. | 19719. | 21351. | 18204. | 21019. |
| 3 | 8150. | 11045. | 12821. | 14024. | 12145. |
| 4 | 4310. | 3787. | 5830. | 5153. | 4697. |
| 5 | 1579. | 1626. | 1555. | 1995. | 1706. |
| 6 | 349. | 473. | 785. | 1058. | 1158. |
| Total | 53682. | 62768. | 64746. | 66421. | 79814. |

| AGE | 2003 | 2004 | 2005 |
|-----|------|------|------|
| 1 | 34263. | 14985. | 0. |
| 2 | 31772. | 27908. | 12199. |
| 3 | 13218. | 22572. | 21643. |
| 4 | 6487. | 6376. | 15336. |
| 5 | 2194. | 3253. | 1593. |
| 6 | 1946. | 2380. | 1408. |
| Total | 89880. | 77474. | 52179. |

# Table C5b. Estimates of fishing mortality from Base Case VPA.

Fishing Mortality Calculated

| AGE | 1973 | 1974 | 1975 | 1976 | 1977 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.0136 | 0.0513 | 0.0751 | 0.0287 | 0.0244 |
| 2 | 0.2681 | 0.5752 | 1.2157 | 1.0381 | 0.7014 |
| 3 | 0.6957 | 0.9056 | 1.3051 | 0.9334 | 1.3234 |
| 4 | 0.9045 | 1.1648 | 1.4349 | 1.0151 | 0.9988 |
| 5 | 0.9045 | 1.1648 | 1.4349 | 1.0151 | 0.9988 |
| 6 | 0.9045 | 1.1648 | 1.4349 | 1.0151 | 0.9988 |

| AGE | 1978 | 1979 | 1980 | 1981 | 1982 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.2246 | 0.0140 | 0.0147 | 0.0019 | 0.1102 |
| 2 | 0.3306 | 0.3913 | 0.2397 | 0.0644 | 0.4855 |
| 3 | 0.9746 | 0.7108 | 0.7665 | 0.6740 | 0.7925 |
| 4 | 0.9500 | 0.9941 | 0.7202 | 1.2366 | 1.0958 |
| 5 | 0.9500 | 0.9941 | 0.7202 | 1.2366 | 1.0958 |
| 6 | 0.9500 | 0.9941 | 0.7202 | 1.2366 | 1.0958 |

| AGE | 1983 | 1984 | 1985 | 1986 | 1987 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.1251 | 0.0537 | 0.0660 | 0.0236 | 0.0189 |
| 2 | 0.7347 | 0.6226 | 0.8343 | 0.7835 | 0.7512 |
| 3 | 1.1881 | 1.3628 | 0.8020 | 0.5313 | 1.2268 |
| 4 | 0.6727 | 1.8053 | 1.0320 | 0.8036 | 1.3377 |
| 5 | 0.6727 | 1.8053 | 1.0320 | 0.8036 | 1.3377 |
| 6 | 0.6727 | 1.8053 | 1.0320 | 0.8036 | 1.3377 |

| AGE | 1988 | 1989 | 1990 | 1991 | 1992 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.0243 | 0.0218 | 0.0223 | 0.0326 | 0.1565 |
| 2 | 0.5870 | 0.1404 | 0.3530 | 0.0177 | 0.8046 |
| 3 | 1.0221 | 0.4540 | 0.8795 | 0.4527 | 0.5742 |
| 4 | 1.5607 | 0.9246 | 0.9352 | 1.3311 | 1.1495 |
| 5 | 1.5607 | 0.9246 | 0.9352 | 1.3311 | 1.1495 |
| 6 | 1.5607 | 0.9246 | 0.9352 | 1.3311 | 1.1495 |

| AGE | 1993 | 1994 | 1995 | 1996 | 1997 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.5276 | 0.0061 | 0.0062 | 0.0045 | 0.0036 |
| 2 | 0.1265 | 0.2656 | 0.0300 | 0.0713 | 0.0792 |
| 3 | 0.7939 | 1.4752 | 0.4609 | 0.3647 | 0.2726 |
| 4 | 1.3208 | 1.6859 | 0.9604 | 0.6348 | 0.7094 |
| 5 | 1.3208 | 1.6859 | 0.9604 | 0.6348 | 0.7094 |
| 6 | 1.3208 | 1.6859 | 0.9604 | 0.6348 | 0.7094 |

Fishing Mortality Calculated

| AGE | 1998 | 1999 | 2000 | 2001 | 2002 |
|-----|--------|--------|--------|--------|--------|
| 1 | 0.0029 | 0.0016 | 0.0077 | 0.0121 | 0.0073 |
| 2 | 0.1152 | 0.2305 | 0.2203 | 0.2047 | 0.2638 |
| 3 | 0.5664 | 0.4390 | 0.7114 | 0.8939 | 0.4272 |
| 4 | 0.7751 | 0.6904 | 0.8726 | 0.9057 | 0.5611 |
| 5 | 0.7751 | 0.6904 | 0.8726 | 0.9057 | 0.5611 |
| 6 | 0.7751 | 0.6904 | 0.8726 | 0.9057 | 0.5611 |

| AGE | 2003 | 2004 |
|-----|--------|--------|
| 1 | 0.0052 | 0.0058 |
| 2 | 0.1419 | 0.0542 |
| 3 | 0.5290 | 0.1865 |
| 4 | 0.4903 | 1.1867 |
| 5 | 0.4903 | 1.1867 |
| 6 | 0.4903 | 1.1867 |

# Table C5c. Estimates of spawning biomass from Base Case VPA.

```
Spawning Stock Biomass


     AGE      1973       1974       1975       1976       1977
_____

      1         0.         0.         0.         0.         0.
      2      2907.      2660.      3200.      4496.      2080.
      3      9107.      4641.      2798.      3276.      4234.
      4      5754.      4142.      1404.       929.      1218.
      5      2652.      2201.       964.       438.       341.
      6      1527.      1162.       681.       859.       521.
==============================================================
Total    21947.     14807.      9048.      9998.      8394.

     AGE      1978       1979       1980       1981       1982
_____

      1         0.         0.         0.         0.         0.
      2      1564.      4120.      2485.      2851.      5706.
      3      2447.      2516.      6366.      4463.      4726.
      4      1449.       984.      1460.      2489.      2097.
      5       476.       480.       416.       506.       783.
      6       224.       329.       192.       101.        99.
==============================================================
Total     6159.      8429.     10919.     10409.     13412.

     AGE      1983       1984       1985       1986       1987
_____

      1         0.         0.         0.         0.         0.
      2      1646.       750.      1835.      2702.      1373.
      3      6351.      1300.       695.      1191.      1388.
      4      2328.      1403.       530.       340.       516.
      5       779.       647.       380.       226.       116.
      6       267.       168.        65.       149.        93.
==============================================================
Total    11371.      4269.      3506.      4608.      3487.

     AGE      1988       1989       1990       1991       1992
_____

      1         0.         0.         0.         0.         0.
      2      1624.      4824.      1670.      1860.      1810.
      3       876.      1332.      3276.      1261.      1690.
      4       385.       347.       638.      1135.       700.
      5       125.       107.       108.       215.       355.
      6        34.        36.        24.        48.        42.
==============================================================
Total     3044.      6647.      5717.      4519.      4597.

     AGE      1993       1994       1995       1996       1997
_____

      1         0.         0.         0.         0.         0.
      2      1661.       737.      1009.      1230.      1591.
      3      1424.      1380.       973.      1932.      2056.
      4       911.       523.       495.       869.      1442.
      5       181.       212.       134.       277.       448.
      6        61.        57.        41.        39.       153.
==============================================================
Total     4239.      2908.      2652.      4346.      5690.
```

Spawning Stock Biomass

| AGE | 1998 | 1999 | 2000 | 2001 | 2002 |
|-----|------|------|------|------|------|
| 1 | 0. | 0. | 0. | 0. | 0. |
| 2 | 2243. | 3162. | 3532. | 2743. | 3441. |
| 3 | 2276. | 3661. | 3628. | 3486. | 3933. |
| 4 | 1559. | 1667. | 2286. | 2028. | 2285. |
| 5 | 726. | 848. | 758. | 1017. | 1030. |
| 6 | 213. | 301. | 520. | 715. | 1024. |
| Total | 7018. | 9639. | 10723. | 9990. | 11713. |

| AGE | 2003 | 2004 |
|-----|------|------|
| 1 | 0. | 0. |
| 2 | 5158. | 3812. |
| 3 | 4002. | 7205. |
| 4 | 3172. | 2079. |
| 5 | 1366. | 1320. |
| 6 | 1651. | 1290. |
| Total | 15349. | 15705. |

Figure C1. Total catch of Georges Bank yellowtail flounder.
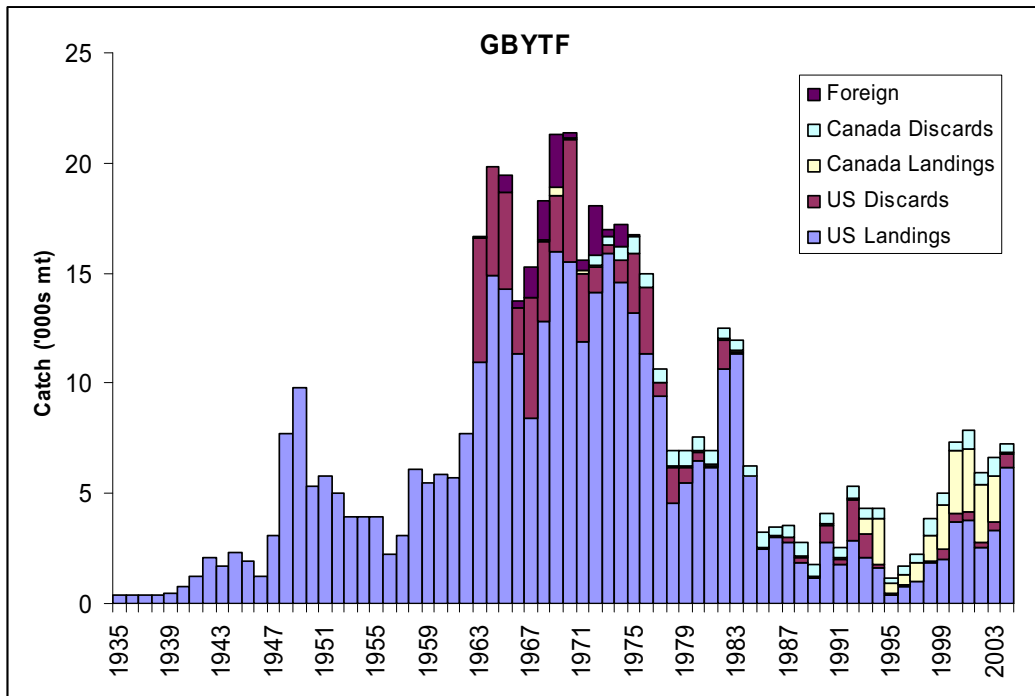


Figure C2. Survey indices of Georges Bank yellowtail flounder biomass.
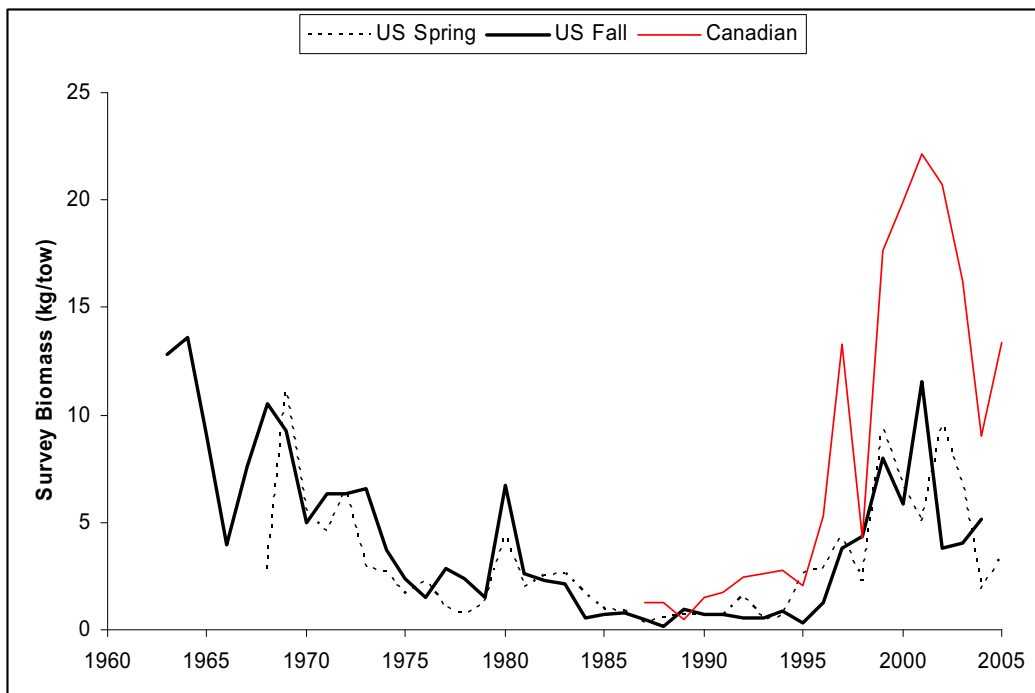
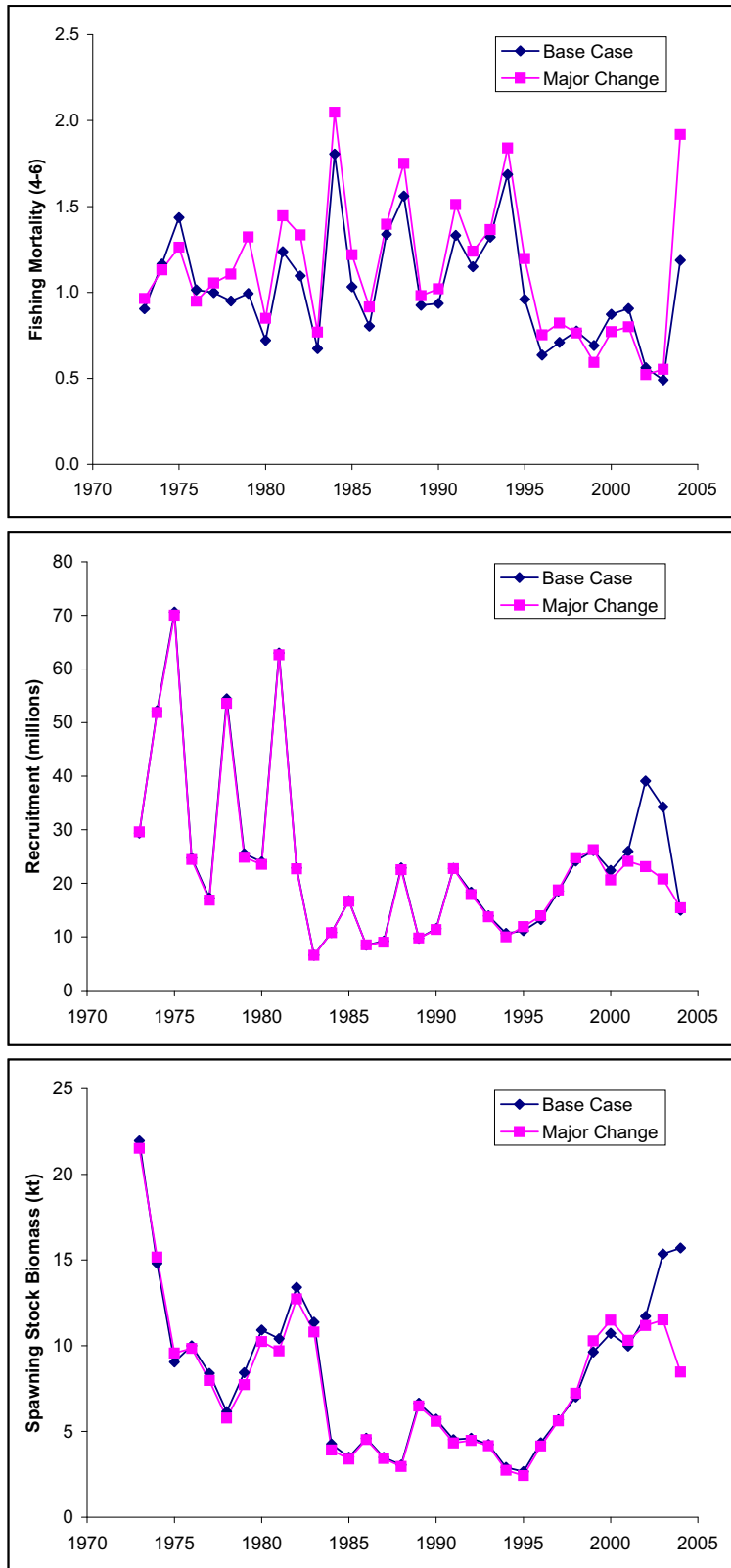Figure C3. Summary of Georges Bank yellowtail flounder VPA results.

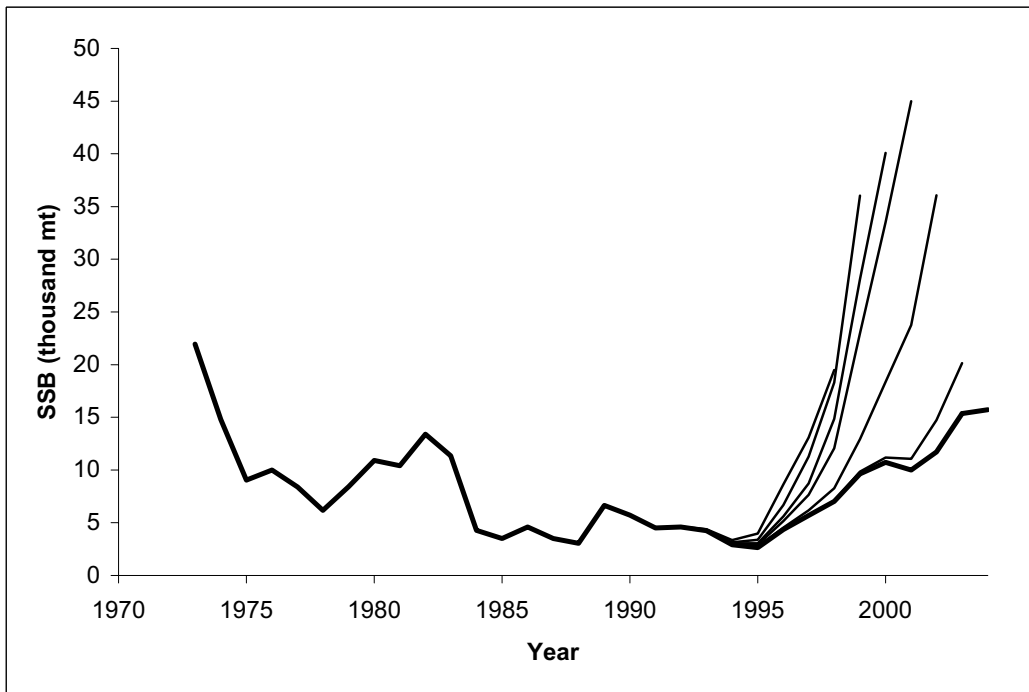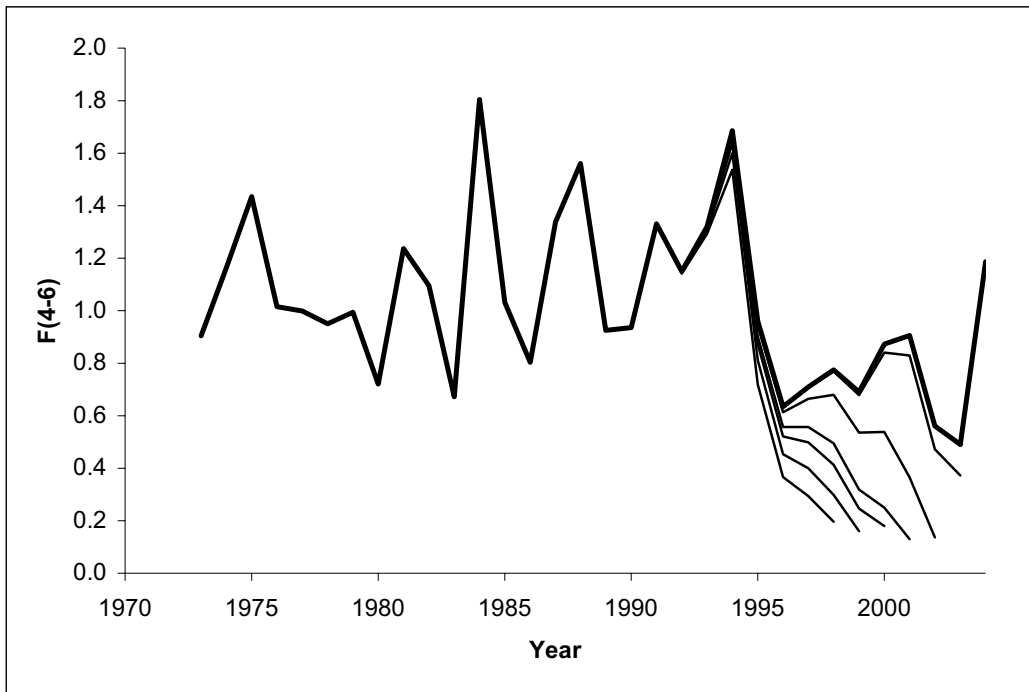Figure C4. Retrospective patterns in Georges Bank yellowtail flounder Base Case VPA.

Figure C5. Comparison of projections from GARM assuming Frebuild=0.22 in years 2003 through 2009 (solid line with symbols; NEFSC 2002b) and results of Base Case VPA from 2005 assessment (heavy solid line = median, dashed lines = interquartile range).