I. Georges Bank Winter Flounder by **Lisa Hendrickson**

1.0 Background

The Georges Bank winter flounder stock was last assessed in 1998 at SAW/SARC 28 (NEFSC 1999). The 1998 VPA assessment incorporated a catch at age from 1982 - 1997 and research survey indices from the U.S. autumn (1963-1997) and spring (1968-1998) surveys, as well as the Canadian spring (1987-1998) surveys. Fully-recruited F (ages 4-6) in 1997 was estimated to be 0.41 and spawning stock biomass was estimated to be 3,500 mt.

In 1999, medium term stochastic projections were generated (NDWG 2000) by deriving a 1998 fishing mortality rate (= 0.42) based on annual landings, then assuming a 1999 fishing mortality rate equal to 1998. Medium term projections were performed by applying the harvest control rule to determine the corresponding level of fishing mortality for 2000 - 2008.

2.0 2000 Assessment Update

The Fishery

Total commercial landings (U.S. and Canadian) of Georges Bank winter flounder have declined since 1997 (1,430 mt) to 1,328 mt in 1998 and 1,019 mt in 1999 (Table I1; Figure I1). Since the late 1960's, U.S. landings have been the predominant component of the total commercial landings. Canadian landings have averaged 0.1% to 2.7% of the total landings since 1970.

Canadian landings in 1997 (143 mt) reached their highest levels since 1966, but have since declined during 1998 and 1999, to 91 mt and 76 mt, respectively. U.S. landings have also declined since 1997. Landings for 1998 and 1999 were estimated, based on prorations, at 1,237 mt and 943 mt, respectively. Discarding of winter flounder occurs at low levels in both the otter trawl and scallop dredge fisheries. However, lack of reliable information to estimate either the magnitude or characterize the size and age distribution of discards precluded discard estimation.

Research Survey Indices

Stratified mean weight (kg) per tow and mean number per tow from the NEFSC spring (April 1968-1999) and autumn (October 1963-1999) bottom trawl surveys, as well as the Canadian spring (1987-1999) bottom trawl surveys, are presented in Table I2. NEFSC autumn survey biomass indices are also shown in relation to the landings for this stock in Figure I1. While landings declined during 1998 and 1999, autumn survey biomass indices increased slightly, reaching their 1996 level in 1999 (1.756 kg/tow).

3.0 Harvest Control Rule

The MSY-based control rule for Georges Bank winter flounder adopted in Amendment 9 was derived from survey-based proxies of biomass and exploitation. The parameters of this control rule were revised during SAW/SARC 28 due to revised estimates of landings and a revision to the strata set used to develop survey indices for the NEFSC spring and autumn surveys. The revised control rule defined maximum sustainable yield as 2,700 mt, and survey equivalents of MSY-based reference points. The F_{MSY} proxy is defined as catch / NEFSC autumn survey biomass index and the B_{MSY} proxy is defined as an autumn survey biomass index value. Threshold F is defined as an F_{MSY} proxy (= 1.125) when the NEFSC autumn survey biomass index is greater than 2.73 kg/tow and declines linearly to zero at 1/2 the B_{MSY} proxy (= 1.37 kg/tow). The target exploitation rate was defined as 75% of the F_{MSY} proxy (=0.84) when the NEFSC autumn survey biomass index is greater than 2.73 kg/tow and declines linearly to zero at 1.37 kg/tow (Figure I2).

Exploitation indices (catch/NEFSC autumn survey biomass index) during 1964-1999 are presented, in Table I3 and Figure I3, in relation to the harvest control rule F_{MSY} proxy (= 1.125). The 1997-1999 mean exploitation index equals 0.787 and the 1997-1999 mean NEFSC autumn survey biomass index equals 1.618 (Figure I2).

The availability of an analytical assessment for this stock provides an opportunity to update the harvest control rule. A revised control rule which incorporated estimates of mean biomass and F weighted by biomass would eliminate the necessity of translating between mean biomass and autumn survey units.

4.0 Forecasts

No stochastic projections were performed for 2000-2001. However, the 1999 U.S. and Canadian landings were used to recalculate the realized F_{1999} (= 0.34). The projected F_{1999} (=0.41) from the analysis conducted in 1999 (NDWG 2000) was assumed to equal the F_{1998}. This projected value for F_{1999} is within the 80th percentile of the recalculated F_{1999} value (= 0.34) (Tables I4 and I5).

5.0 Sources of Uncertainty

- Sampling of U.S. commercial landings may be inadequate to characterize the size and age composition, particularly in the years since 1992. This leads to uncertainty in the age composition of landings in the catch at age matrix.

- The exclusion of U.S. otter trawl and scallop dredge discards most likely results in an underestimation of fishery removals from the younger age classes (ages 0 to 3). Indications from both the sea sample and vessel trip record databases suggests that scallop dredge discards may have increased since the implementation of groundfish retention restrictions resulting in an underestimation of fishery removals of both younger and older age classes.

- There is some uncertainty about the accuracy of reported Canadian landings because of the non-targeted nature of the Canadian fishery and the tendency to report landings of some flatfish species, including winter flounder, as unclassified flounders.

- The Canadian fishery has no formal sampling program to estimate the size and age composition of Canadian landings. This assessment assumed that the size and age composition of Canadian landings was identical to the overall size and age composition in the U.S. fishery. This assumption is sensitive to the possibility that selectivity patterns may be different between the fisheries in each country.

6.0 References

NEFSC [Northeast Fisheries Science Center]. 1999. Report of the 28th Northeast Regional Stock Assessment Workshop (28th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. *Northeast Fish. Sci. Cent. Ref. Doc.* 99-08; 304 p.

NDWG [Northern Demersal Working Group], Northeast Regional Stock Assessment Workshop. 2000. Assessment of 11 Northeast groundfish stocks through 1999: a report to the New England Fishery Management Council's Multi-Species Monitoring Committee. *Northeast Fish. Sci. Cent. Ref. Doc.* 00-05; 175 p.

Table 11. Landings (mt) of Georges Bank winter flounder from 1962-1999 by statistical area and country.

	522-525	5Z (521-543)				5ZE (521-526, 541-543)				
	USA	USA	Canada	USSR	Total	USA	Canada	USSR	Total	Assessment
1962		6996	26		7022					
1963		6911	120	19	7050					
1964	1371	12656	146		12802					1517
1965	1176	10479	199	312	10990					1687
1966	1877	13807	164	156	14127					2197
1967	1917	10815	83	349	11247					2349
1968	1570		57			4346	59	372	4777	1999
1969	2167		116			6380		235	6615	2518
1970	2615		61			7020	64	40	7124	2716
1971	3092		62			14000	65	1029	15094	4183
1972	2805		8			10266	8	1699	11973	4512
1973	2269		14			4387	14	693	5094	2976
1974	2124		12			4508	12	82	4602	2218
1975	2409		13			4833	13	515	5361	2937
1976	1877		15			3732	11	1	3744	1893
1977	3572		15			5954	15	7	5976	3594
1978	3185		65			6378	65		6443	3250
1979	3045		19			6293	19		6312	3064
1980	3931		44			9941	44		9985	3975
1981	3993		19			9711	19		9730	4012
1982	2961		19			7347	19		7366	2980
1983	3894		14			8014	14		8028	3908
1984	3927		4			7574	4		7578	3931
1985	2151		12			4758	11		4769	2163
1986	1762		25							1787
1987	2637		32							2669
1988	2804		55							2859
1989	1880		11							1891
1990	1898		55							1953
1991	1814		14							1828
1992	1822		27							1849
1993	1662		21							1683
1994	907		65							972
1995	706		54							760
1996	1265		71							1336
1997	1287		143							1430
1998	1237		91							1328
1999	943		76							1019

Table 12. Standardized, stratified abundance (numbers) and biomass (weight) indices for Georges Bank winter flounder from the U.S. NEFSC Spring and Autumn, and Canadian Spring research vessel bottom trawl surveys. U.S. offshore survey strata 13-22; Canadian survey strata (5Z1-5Z8). Canadian biomass indices were estimated using the stratified mean number at length and the U.S. survey length-weight regression coefficients. Door standardization coefficients of 1.46 (numbers) and 1.39 (weight) applied to U.S. survey indices before 1985 to account for differences in catchability between survey doors.

	U.S. Spring Survey		**U.S. Autumn Survey**		**Canada Spring Survey**	
	Number/tow	kg/tow	Number/tow	kg/tow	Number/tow	kg/tow
1963			1.200	1.815		
1964			1.298	1.822		
1965			2.152	2.050		
1966			5.163	5.655		
1967	*Spring Survey initiated in 1968*		1.791	2.074		
1968	2.700	3.114	1.308	1.072		
1969	3.136	4.290	2.370	2.385		
1970	1.864	2.294	5.620	6.490		
1971	1.838	2.168	1.324	1.259		
1972	4.946	5.321	1.261	1.580		
1973	2.946	3.507	1.218	1.195		
1974	6.049	5.782	1.193	1.464		
1975	1.955	1.407	3.790	2.061		
1976	4.672	3.012	5.987	3.925		
1977	3.792	1.580	4.862	3.992		
1978	7.068	5.055	4.056	3.100		
1979	1.736	2.206	5.065	3.829		
1980	3.221	2.801	1.661	1.865		
1981	3.727	3.749	3.831	2.434		
1982	2.295	1.523	5.301	2.692		
1983	8.405	7.111	2.726	2.363		
1984	5.529	5.604	3.933	2.445		
1985	3.837	2.650	1.979	1.119		
1986	2.003	1.214	3.575	2.178	*Canadian Survey initiated in 1987*	
1987	2.803	1.247	0.762	0.889	3.73	2.83
1988	2.925	1.648	4.084	1.273	2.70	1.65
1989	1.299	0.757	1.560	1.051	3.48	1.88
1990	2.803	1.573	0.498	0.346	3.29	1.74
1991	2.403	1.319	0.268	0.136	1.43	0.97
1992	1.416	0.898	0.677	0.384	2.25	1.39
1993	1.018	0.570	1.166	0.663	2.78	1.45
1994	1.292	0.578	0.870	0.578	2.45	0.98
1995	2.613	1.489	2.357	1.337	3.10	1.17
1996	2.314	1.504	1.539	1.756	2.20	1.12
1997	1.610	1.192	1.744	1.534	2.80	1.77
1998	0.762	0.722	1.784	1.565	1.42	1.08
1999	3.830	3.479	1.539	1.756	0.98	0.74
2000	4.420	3.693				

Table 13. Exploitation indices (catch/NEFSC autumn survey biomass index) for Georges Bank winter flounder during 1964-1999.

Year	Exploitation Index
1964	0.833
1965	0.823
1966	0.389
1967	1.133
1968	1.865
1969	1.056
1970	0.418
1971	3.322
1972	2.856
1973	2.490
1974	1.515
1975	1.425
1976	0.482
1977	0.900
1978	1.048
1979	0.800
1980	2.131
1981	1.648
1982	1.107
1983	1.654
1984	1.608
1985	1.933
1986	0.820
1987	3.002
1988	2.246
1989	1.799
1990	5.645
1991	13.441
1992	4.815
1993	2.538
1994	1.682
1995	0.568
1996	0.761
1997	0.932
1998	0.849
1999	0.580

Table I4. Input file for stochastic projection program used to recalculate realized F_{1999} (= 0.34).

```
GB Winter Flounder
     1998
        3
      100
  4577161
        0
        1
        0
        0
        0
        0
        0
        1
        0
        0
        0
        0
        0
        1
        1
        7  1  7
   0.200000
   0.168000    0.300000    0.474000    0.670000    0.917000    1.195000    1.73400
   0.221000    0.387000    0.573000    0.788000    1.055000    1.137200    1.73500
   0.000000    0.620000    0.920000    1.000000    1.000000    1.000000    1.00000
   0.200000
        3
       16
   4627000 2725000 6089000 5963000 8027000 5307000 9002000 5243000
   3327000 4523000 2441000 2906000 4813000 6944000 2987000  946000
     1000
bootN.dat
       1000.000
   0.000    11400000.000   0.33
   0.0000   0.540000    0.860000    1.000000    1.000000    1.000000    1.000000
   1 1 0
   1328000 1019000 0
   0.0  0.0  0.420
```

Table I5. Output file from stochastic projection program used to recalculate realized F_{1999} (= 0.34).

```
PROJECTION RUN: GB Winter Flounder
 INPUT FILE: gbwf2.inp
 OUTPUT FILE: gbwf2.out
 RECRUITMENT MODEL: 3
 NUMBER OF SIMULATIONS: 100

 MIXTURE OF F AND QUOTA BASED CATCHES
 YEAR   F       QUOTA (THOUSAND MT)
 1998              1.328
 1999              1.019
 2000  0.420

 SPAWNING STOCK BIOMASS (THOUSAND MT)
 YEAR    AVG SSB (000 MT)    STD
 1998         3.292         0.597
 1999         3.203         0.689
 2000         3.574         0.752

 PERCENTILES OF SPAWNING STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998      1.996      2.354      2.568      2.861      3.281      3.670      4.042      4.320      4.805
 1999      1.747      2.113      2.379      2.717      3.184      3.635      4.063      4.405      4.960
 2000      1.951      2.391      2.643      3.064      3.545      4.050      4.534      4.849      5.519

ANNUAL PROBABILITY THAT SSB EXCEEDS THRESHOLD:     0.000 THOUSAND MT
 YEAR    Pr(SSB > Threshold Value)
 1998            1.000
 1999            1.000
 2000            1.000

 MEAN BIOMASS (THOUSAND MT) FOR AGES:1 TO 7
 YEAR   AVG MEAN B (000 MT)      STD
 1998         4.202             0.692
 1999         4.560             0.853
 2000         4.942             0.917

 PERCENTILES OF MEAN STOCK BIOMASS (000 MT)
 YEAR       1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998      2.704      3.109      3.382      3.719      4.179      4.631      5.064      5.393      5.962
 1999      2.723      3.221      3.501      3.982      4.528      5.106      5.648      6.003      6.731
 2000      2.932      3.480      3.785      4.306      4.913      5.550      6.133      6.487      7.202

ANNUAL PROBABILITY THAT MEAN BIOMASS EXCEEDS THRESHOLD:    11.400 THOUSAND MT
 YEAR    Pr(MEAN B > Threshold Value)
 1998            0.000
 1999            0.000
 2000            0.000

 F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7
 YEAR  AVG F_WT_B        STD
 1998    0.325          0.056
 1999    0.232          0.046
 2000    0.280          0.030

 PERCENTILES OF F WEIGHTED BY MEAN BIOMASS FOR AGES:1 TO 7
 YEAR   1%     5%     10%    25%    50%    75%    90%    95%    99%
 1998  0.221  0.245  0.262  0.287  0.318  0.357  0.393  0.426  0.489
 1999  0.151  0.170  0.180  0.200  0.225  0.256  0.291  0.316  0.374
 2000  0.209  0.230  0.241  0.259  0.280  0.301  0.318  0.329  0.349

ANNUAL PROBABILITY THAT F WEIGHTED BY MEAN BIOMASS EXCEEDS THRESHOLD: 0.330
 YEAR    Pr(F_WT_B > Threshold Value)
 1998            0.404
 1999            0.034
 2000            0.046

  RECRUITMENT UNITS ARE:1000. FISH
 BIRTH       AVG
 YEAR     RECRUITMENT      STD
 1998      4738.131      2088.952
 1999      4748.381      2091.011
 2000      4726.709      2087.938

 PERCENTILES OF RECRUITMENT UNITS ARE:1000. FISH
 BIRTH
 YEAR      1%         5%         10%        25%        50%        75%        90%        95%        99%
 1998    946.000    946.000   2441.000   2906.000   4627.000   5963.000   8027.000   9002.000   9002.000
 1999    946.000    946.000   2441.000   2987.000   4627.000   6089.000   8027.000   9002.000   9002.000
 2000    946.000    946.000   2441.000   2906.000   4627.000   5963.000   8027.000   9002.000   9002.000
```

Table I5. (Cont.)

LANDINGS FOR F-BASED PROJECTIONS

YEAR	AVG LANDINGS (000 MT)	STD
1998	1.328	0.000
1999	1.019	0.000
2000	1.380	0.281

PERCENTILES OF LANDINGS (000 MT)

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	1.328	1.328	1.328	1.328	1.328	1.328	1.328	1.328	1.328
1999	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019	1.019
2000	0.766	0.937	1.030	1.189	1.370	1.559	1.738	1.857	2.095

REALIZED F SERIES FOR QUOTA-BASED PROJECTIONS

YEAR	AVG F	STD
1998	0.442	0.097
1999	0.352	0.091
2000	0.420	0.000

PERCENTILES OF REALIZED F SERIES

YEAR	1%	5%	10%	25%	50%	75%	90%	95%	99%
1998	0.276	0.315	0.336	0.375	0.424	0.494	0.561	0.621	0.749
1999	0.206	0.235	0.257	0.290	0.335	0.396	0.460	0.516	0.641
2000	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420	0.420

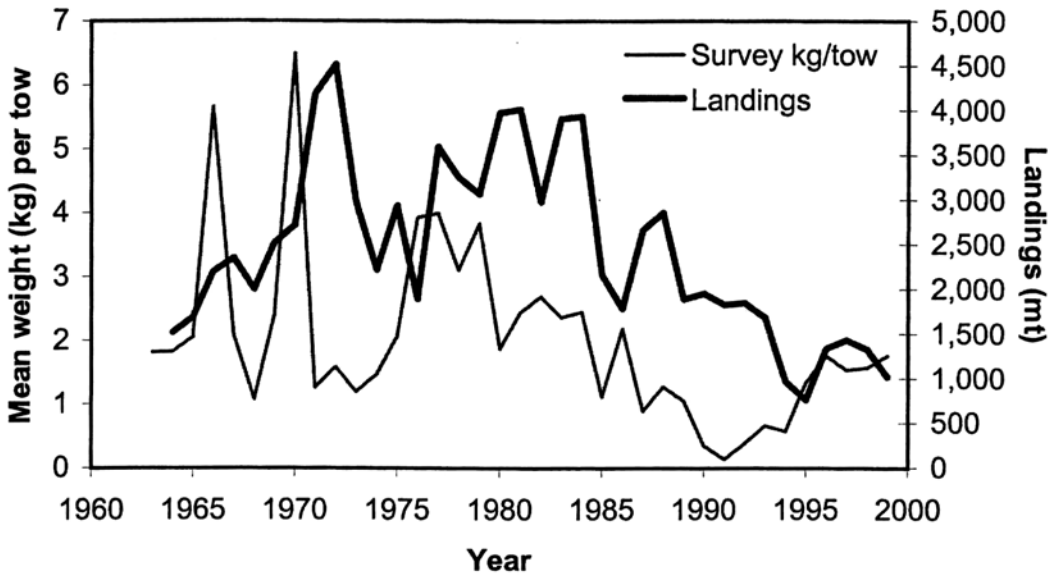

Figure I1. Total commercial landings (U.S. and Canadian) of Georges Bank winter flounder, 1964-1999, and NEFSC autumn bottom trawl survey stratified mean weight (kg) per tow in 1963-1999.

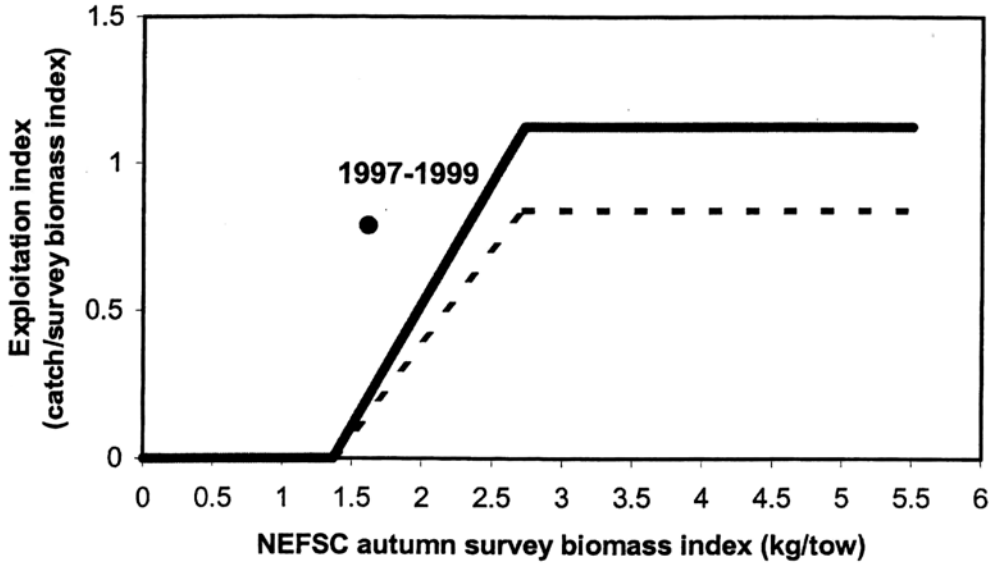

Figure I2. Harvest control rule for Georges Bank winter flounder based on survey equivalents of MSY-based reference points and 1997-1999 mean exploitation index.

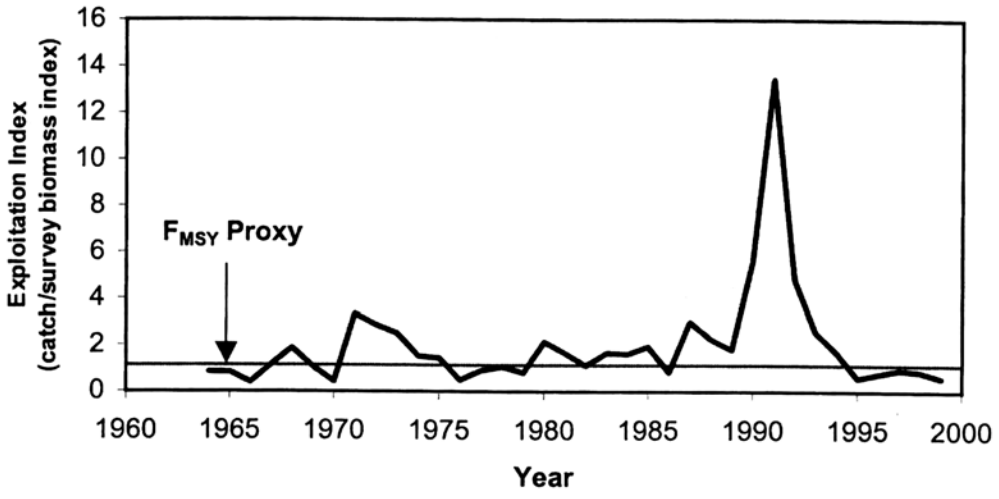

Figure I3. Trends in Georges Bank winter flounder exploitation indices (catch/autumn survey biomass index), during 1964-1999, in relation to the harvest control rule F_{MSY} proxy (= 1.125).