GULF OF MEXICO GREATER AMBERJACK VIRTUAL POPULATION ASSESSMENT

Craig A. Brown, Clay E. Porch and Gerald P. Scott
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, FL 33149

September 2005

SFD Contribution Number – SFD-2005-040

As was done in the last stock assessment of Gulf of Mexico greater amberjack (Turner et al. 2000), a virtual population analysis (VPA) was conducted using the program VPA-2box (Porch 1999). VPA-2box employs methods similar to the ADAPT approach (Powers and Restrepo 1992) to obtain estimates of population abundance and mortality rates.

The last assessment was conducted using available catch and abundance index data through 1998. To focus on the effect of adding data though 2004, a continuity case VPA run was conducted using model inputs as close as possible to those used by Turner et al. (2000), with the addition of the data from more recent years.

Some differences in data treatment were necessary. Catch-at-size was developed using yearly size samples, applied to monthly catch data, when it was determined that sample sizes were insufficient to use monthly size samples. Catch-at-age was then calculated by applying the same monthly age slicing approach used by Turner et al. (2000). The discard component of catch-at-age was calculated by assuming that the catches of ages 0-3 after the implementation of bag and size limits beginning in 1990 were similar in proportion to catches of age 4 and 5+ as they were in the period 1986-1989. Based upon recommendations emerging from the data workshop, 20% of the total discards were assumed to have died. This procedure may have resulted in a somewhat different catch-at-age matrix from that used for the 2000 stock assessment.

Abundance indices were available from the same fisheries as previously, although the indices were developed anew to include the more recent years. The computer programs used to conduct the 2000 analysis and these analyses were slightly different. For the 2000 run, a special version of VPA-2box was written. The latest analyses were conducted using the standard version of the software.

No SVPA was conducted to estimate the relative selectivity of each of the ages in the terminal year (as was done in 2000); instead, an initial run of the VPA was conducted, estimating the Fs of all ages in the terminal ear but constraining Fs and recruitment for the last 3 years.

As was done in 2000, for the continuity run index values were weighted by the coefficients of variation estimated in the standardization process (input variance weighting). Two additional abundance indices were available for the current assessment which were not used in 2000, one developed from catch rate data from the longline fishery, and a fishery independent index developed from SEAMAP reef fish video survey data. Another VPA run was conducted using all available indices (Option 1).

Because the measures of uncertainty were not truly comparable between the indices, a VPA run was performed with equal weighting among indices (Option 2).

For each index, the estimated selectivity pattern was constrained to be identical across the catch history (one pattern estimated for the entire time period). This assumption of year-constant index selectivity may be inappropriate considering that changes in selectivity clearly occurred after size limits were implemented in 1990. Therefore, an additional VPA run was conducted in which the selectivity of the handline index was allowed to vary over time (Option 3). As in Option 2, equal weighting was employed for the indices.

For the projections, future catches for 2005 and 2006 are assumed to be 3,800,000 and 5,800,000 lbs, based upon current quotas. For subsequent years, two scenarios were examined: $F_{30\%}$ and $F_{40\%}$. Uncertainty was incorporated based upon 501 bootstrap results from each VPA run.

The biological parameters used are detailed in Table 1.

Alternative age slicing

Subsequent to the stock assessment workshop, the age slicing methodology was revisited. For the continuity case and Options 1-3, the catch-at-age matrix was calculated by applying monthly slicing limits, the same as those used in the previous assessment, to the catch –at-size data. These slicing limits were based upon the growth curve developed by Thompson et al. (1999), assuming a birth date of June 1.

Unfortunately, there was insufficient size sample information to adequately create catch-at-size on a monthly basis. Instead, yearly size samples were applied to the corresponding catches. Therefore, it is considered inappropriate to apply month-specific age slicing limits to the catch-at-size. Alternative yearly slicing limits were constructed (Table 2). The upper and lower limits of each age class were based upon the expected curved fork length for each age on December 31 and January 1, respectively. Furthermore, the birth date was assumed to be April 1, as this was the birth date assumed by Thompson et al. (1999) in developing the growth curve. Adjustments were made to model input files as necessary to account for the April 1 assumed birth date.

For the continuity case and Options 1-3, weight-at-age inputs were the same as used for the previous assessment. These weights were calculated from the growth curve, but corresponded to the weights-at-age at the end of the year. Since it was more appropriate to use mid-year weight-at-age, these were used for the preferred case. Mid-year and spawning weight-at-age were calculated assuming the April 1 birth date.

In all other respects, the model inputs for the run using the alternative age slicing approach (Option 4) corresponded to those of Option 3.

Results

Comparison with 2000 Assessment

Estimated F at age and N at age for the continuity case are shown in Tables 3 and 4. The catch-at-age matrix used for this run (as well as for Options 1-3) is shown in Table 5, and the estimated spawning stock biomass and recruitment in Table 6. Fits to the indices are shown in Table 7 and in Figure 1.

The Continuity Case run produced similar results to those of the 2000 assessment (Figure 2); divergences in the last 3 years of the data available to the 2000 assessment (1997-1999) are not necessarily significant, since VPA results are typically more uncertain for the most recent years of a series.

Estimates of stock status in the terminal year based on 501 bootstrap results are shown in Figure 3. The predicted yields from bootstrapped projection runs using the Continuity Case VPA results are shown in Figure 4 for the F30% and F40% scenarios. Inputs and diagnostic output files are appended.

Alternative age slicing approach – Option 4 (Preferred Case)

Estimated F at age and N at age for Option 4 (preferred case) are shown in Tables 8 and 9. The catch-at-age matrix used for this run, resulting from the alternative age slicing approach, is shown in Table 10, and the estimated spawning stock biomass and recruitment in Table 11. Fits to the indices are shown in Table 12 and in Figure 5 and include the two additional indices.

Estimates of stock status in the terminal year based on 501 bootstrap results from the Option 4 run are shown in Figure 6. The predicted yields from bootstrapped projection runs using the alternative VPA case are shown in Figure 7 for the F30% and F40% scenarios. Inputs and diagnostic output files are appended.

Benchmarks for both the Continuity Case and Option 4/Preferred Case are shown in Table 13. The projected yields for each case are shown in Tables 14 and 15, and the ratio of projected spawning stock biomass to benchmarks are shown in Table 16 (SSB/SSB30) and Table 17 (SSB/SSB40).

Discussion

The alternative VPA case (Option 4) is considered the preferred option because the application of yearly slicing limits is considered more appropriate than monthly slicing limits as the catch was not sized from monthly size samples. Nevertheless, there likely remain flaws with this alternative approach to generating catch-at-age. Since the maximum slicing limit for each age class is set equal to the expected size at the end of the year for that age class, fish caught late in the year which grow faster than average (or which grow at about average rates but which are born earlier in the year than assumed) will be mis-assigned to the next older age class. Similarly, fish caught early in the year which grow slower than average (or which grow at about average rates but which are born later in the year than assumed) will be mis-assigned to the next younger age class. However, the monthly slicing approach used for previous VPA runs would likely have resulted in a higher frequency of mis-assignments, in addition to a bias toward assigning to younger age classes.

Ultimately, the ability to effectively define cohorts from the catch data may be greatly compromised by the lack of sufficient monthly size samples. This calls into question the accuracy of VPA results, which depend upon the assumption that catch at age is known exactly. The possible effect of violations of this assumption have not been considered in this analysis.

Literature Cited

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Porch, C. E. 1999. A Bayesian VPA with randomly walking parameters. Int. Comm. Conserv. Atl. Tunas. Col. Vol Sci. Pap. 49(2): 314-326.

Thompson, B.A., M. Beasley and C.A. Wilson. 1999. Age distribution and growth of greater amberjack, *Serioal dumerili*, from the north-central Gulf of Mexico. Fish. Bull. 97:362-371

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Table 1. Biological parameters used for VPA and projection runs.

<table>
<tr><td>Natural mortality</td><td>Assumed to be 0.25 for all ages</td></tr>
<tr><td>Assumed “birth date” of age 0 fish</td><td>Continuity Case: June
Preferred Case/Option 4: April 1 (also approximate mid-point of the peak spawning season)</td></tr>
<tr><td>Plus group</td><td>Age 5+</td></tr>
<tr><td>Growth rates</td><td>Length at age was calculated from the Thompson et al. (1999) growth equation:

$FL_{(cm)} = 138.9 * (1 - \exp^{(-0.246 * (t-(-0.79)))})$</td></tr>
<tr><td>Weights at age</td><td>Average weights-at-age were based on the Thompson et al. (1999) growth equation and the Manooch and Potts (1997) length-weight relationship:

$W_{(kg)} = 5.3 \times 10^{-8} * (L_{(cm)} * 10)^{2.976}$

For historical catches only, the following values were used:
<table>
<tr><td>age</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5+</td></tr>
<tr><td>weight$_{(lbs)}$ (mid-year and peak spawning, Continuity Case[1])</td><td>2.04</td><td>7.42</td><td>15.13</td><td>23.8</td><td>32.43</td><td>47.43</td></tr>
<tr><td>weight$_{(lbs)}$ (mid-year, Preferred Case/Option 4[2])</td><td>0.98</td><td>5.30</td><td>12.39</td><td>20.87</td><td>29.60</td><td>45.17</td></tr>
<tr><td>weight$_{(lbs)}$ (peak spawning, Preferred Case/Option 4[2])</td><td>0.61</td><td>4.35</td><td>11.07</td><td>19.41</td><td>28.16</td><td>43.59</td></tr>
</table>

[1] Continuity Case calculated predicted length using a birth date of Jan 1.
[2] Preferred Case/Option 4 calculated predicted length using a birth date of April 1.</td></tr>
<tr><td>Maturity schedule</td><td>
<table>
<tr><td>age</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5+</td></tr>
<tr><td></td><td>0</td><td>0</td><td>0</td><td>0.5</td><td>1.0</td><td>1.0</td></tr>
</table>
</td></tr>
<tr><td>Fecudity at age</td><td>Weight at age is used as a proxy for fecundity at age</td></tr>
</table>

TABLE 2: New Yearly Age Slicing Limits (cm, fork length, integer value)

Age Class	*lower limit*	*upper limit*
0	0	43
1	44	64
2	65	80
3	81	93
4	94	103
5+	104	Infinity

TABLE 3. FISHING MORTALITY RATES FOR CONTINUITY CASE

	0	1	2	3	4	5
1987	0.189	0.408	0.487	0.525	0.405	0.405
1988	0.123	0.604	0.608	0.424	0.34	0.34
1989	0.118	0.541	0.646	0.893	0.799	0.799
1990	0.044	0.092	0.163	0.393	0.446	0.446
1991	0.045	0.167	0.434	0.879	0.646	0.646
1992	0.043	0.113	0.52	0.569	0.478	0.478
1993	0.041	0.192	0.41	0.986	0.845	0.845
1994	0.054	0.134	0.478	0.735	0.886	0.886
1995	0.123	0.162	0.341	0.47	0.637	0.637
1996	0.037	0.26	0.692	0.707	0.69	0.69
1997	0.054	0.139	0.441	0.51	0.446	0.446
1998	0.045	0.166	0.353	0.709	0.435	0.435
1999	0.024	0.125	0.381	0.227	0.427	0.427
2000	0.037	0.111	0.548	0.688	0.408	0.408
2001	0.163	0.296	0.69	0.398	0.517	0.517
2002	0.126	0.175	0.535	0.581	0.512	0.512
2003	0.15	0.255	0.618	0.47	0.657	0.657
2004	0.167	0.247	0.669	0.514	0.55	0.55

TABLE 4. ABUNDANCE AT THE BEGINNING OF THE YEAR FOR CONTINUITY CASE

	0	1	2	3	4	5
1987	852998	833026	358243	154410	69016	100596
1988	871339	549681	431250	171498	71107	88120
1989	882588	600282	234003	182808	87446	88268
1990	754508	611126	272153	95510	58310	61543
1991	558314	562290	434204	180059	50230	59755
1992	459561	415602	370500	219077	58244	44906
1993	497141	342707	288971	171521	96577	49807
1994	421896	371694	220293	149281	49832	48986
1995	229951	311397	253047	106387	55737	31726
1996	325358	158377	206290	140191	51809	36019
1997	329497	244148	95131	80396	53834	34317
1998	395718	243237	165399	47651	37593	43939
1999	725765	294537	160380	90463	18263	41104
2000	996546	551808	202373	85320	56122	30167
2001	989320	747645	384543	91147	33379	44689
2002	653153	654303	432923	150253	47689	36260
2003	524544	448635	427584	197477	65472	39183
2004	308711	351758	270691	179421	96136	42241
2005		203410	213900	108012	83583	62149

TABLE 5. CATCH-AT-AGE USED FOR CONTINUITY CASE

	0	1	2	3	4	5
1987	130751	249214	123367	56446	20499	29879
1988	89205	223268	176072	52855	18260	22629
1989	86820	224426	99856	97260	43279	43686
1990	28795	47513	36357	27664	18736	19775
1991	21847	76853	136509	94833	21427	25490
1992	17285	39515	134388	85111	19777	15248
1993	17603	53162	86816	97076	49583	25571
1994	19534	41502	74783	69807	26389	25941
1995	23588	41295	65082	35615	23545	13402
1996	10506	32226	92495	63800	23168	16107
1997	15213	28193	30310	28726	17306	11032
1998	15522	33122	43889	21727	11836	13834
1999	15250	30769	45329	16358	5666	12752
2000	32362	51476	76365	38104	16777	9018
2001	132444	170716	171961	26685	12048	16130
2002	68392	93485	160457	59266	17087	12992
2003	64681	89895	176721	66146	28287	16929
2004	42199	68573	118412	64474	36419	16002

TABLE 6. SPAWNING STOCK FECUNDITY AND RECRUITMENT FOR CONTINUITY CASE

year	spawning biomass	recruits from VPA
1987	6662.	852998.
1988	6610.	871339.
1989	5884.	882588.
1990	4466.	754508.
1991	4409.	558314.
1992	4818.	459561.
1993	4699.	497141.
1994	3630.	421896.
1995	3225.	229951.
1996	3409.	325358.
1997	3219.	329497.
1998	2862.	395718.
1999	2798.	725765.
2000	3156.	996546.
2001	3153.	989320.
2002	3641.	653153.
2003	4467.	524544.
2004	5219.	308711.

TABLE 7. FITS TO INDEX DATA FOR CONTINUITY CASE

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7.1 MRFSS RR

Lognormal dist.
average numbers
Ages 0 - 5
log-likelihood = -6.65
deviance = 56.94
Chi-sq. discrepancy= 94.84

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.948	0.480	0.468	0.237	0.242E-06	0.289	0.181	5.273
1988	0.495	0.447	0.048	0.293	0.242E-06	0.184	0.175	0.000
1989	1.346	0.231	1.115	0.240	0.242E-06	0.431	0.141	64.806
1990	-0.498	0.295	-0.793	0.631	0.242E-06	0.068	0.151	0.809
1991	0.819	0.408	0.411	0.239	0.242E-06	0.254	0.169	3.688
1992	0.666	0.310	0.355	0.178	0.242E-06	0.218	0.153	5.056
1993	0.156	0.126	0.030	0.316	0.242E-06	0.131	0.127	0.004
1994	-0.088	-0.034	-0.053	0.419	0.242E-06	0.103	0.108	0.090
1995	-0.468	-0.101	-0.368	0.660	0.242E-06	0.070	0.101	0.360
1996	-0.536	-0.297	-0.239	0.531	0.242E-06	0.066	0.083	0.306
1997	-0.903	-0.516	-0.387	0.600	0.242E-06	0.045	0.067	0.432
1998	-1.014	-0.399	-0.615	0.468	0.242E-06	0.041	0.075	1.084
1999	-0.705	-0.154	-0.551	0.299	0.242E-06	0.055	0.096	2.158
2000	-0.331	0.124	-0.455	0.219	0.242E-06	0.081	0.127	2.951
2001	-0.258	0.368	-0.626	0.234	0.242E-06	0.087	0.162	4.077
2002	0.447	0.416	0.031	0.133	0.242E-06	0.175	0.170	0.028
2003	0.308	0.346	-0.038	0.144	0.242E-06	0.153	0.158	0.105
2004	-0.382	0.065	-0.447	0.194	0.242E-06	0.077	0.120	3.617

Selectivities by age

Year	0	1	2	3	4	5
1987	0.154	0.339	1.000	0.991	0.653	0.569
1988	0.154	0.339	1.000	0.991	0.653	0.569
1989	0.154	0.339	1.000	0.991	0.653	0.569
1990	0.154	0.339	1.000	0.991	0.653	0.569
1991	0.154	0.339	1.000	0.991	0.653	0.569
1992	0.154	0.339	1.000	0.991	0.653	0.569
1993	0.154	0.339	1.000	0.991	0.653	0.569
1994	0.154	0.339	1.000	0.991	0.653	0.569
1995	0.154	0.339	1.000	0.991	0.653	0.569
1996	0.154	0.339	1.000	0.991	0.653	0.569
1997	0.154	0.339	1.000	0.991	0.653	0.569
1998	0.154	0.339	1.000	0.991	0.653	0.569
1999	0.154	0.339	1.000	0.991	0.653	0.569
2000	0.154	0.339	1.000	0.991	0.653	0.569
2001	0.154	0.339	1.000	0.991	0.653	0.569
2002	0.154	0.339	1.000	0.991	0.653	0.569
2003	0.154	0.339	1.000	0.991	0.653	0.569
2004	0.154	0.339	1.000	0.991	0.653	0.569

7.2 HEADBOAT RR

Lognormal dist.
average numbers
Ages 0 - 5
log-likelihood = 7.22
deviance = 17.90
Chi-sq. discrepancy= 17.71

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.370	0.473	-0.103	0.277	0.201E-06	0.092	0.101	0.218
1988	0.440	0.445	-0.006	0.248	0.201E-06	0.098	0.099	0.020
1989	0.747	0.268	0.478	0.211	0.201E-06	0.133	0.083	7.345
1990	-0.130	0.276	-0.406	0.377	0.201E-06	0.056	0.083	0.942
1991	-0.358	0.387	-0.745	0.485	0.201E-06	0.044	0.093	1.261
1992	-0.217	0.341	-0.558	0.416	0.201E-06	0.051	0.089	1.194
1993	-0.570	0.141	-0.711	0.488	0.201E-06	0.036	0.073	1.185
1994	-0.604	-0.004	-0.600	0.543	0.201E-06	0.035	0.063	0.807
1995	-0.122	-0.106	-0.017	0.418	0.201E-06	0.056	0.057	0.051
1996	-0.466	-0.247	-0.219	0.590	0.201E-06	0.040	0.049	0.253
1997	-0.494	-0.464	-0.029	0.503	0.201E-06	0.039	0.040	0.072
1998	-0.359	-0.437	0.077	0.535	0.201E-06	0.044	0.041	0.012
1999	-0.389	-0.125	-0.264	0.575	0.201E-06	0.043	0.056	0.312
2000	-0.147	0.136	-0.283	0.489	0.201E-06	0.055	0.072	0.407
2001	0.373	0.343	0.030	0.351	0.201E-06	0.092	0.089	0.007
2002	0.623	0.401	0.222	0.340	0.201E-06	0.118	0.094	0.259
2003	0.542	0.364	0.179	0.364	0.201E-06	0.109	0.091	0.100
2004	0.762	0.119	0.643	0.402	0.201E-06	0.135	0.071	3.261

Selectivities by age

Year	0	1	2	3	4	5
1987	0.113	0.227	0.537	1.000	0.525	0.235
1988	0.113	0.227	0.537	1.000	0.525	0.235
1989	0.113	0.227	0.537	1.000	0.525	0.235
1990	0.113	0.227	0.537	1.000	0.525	0.235
1991	0.113	0.227	0.537	1.000	0.525	0.235
1992	0.113	0.227	0.537	1.000	0.525	0.235
1993	0.113	0.227	0.537	1.000	0.525	0.235
1994	0.113	0.227	0.537	1.000	0.525	0.235
1995	0.113	0.227	0.537	1.000	0.525	0.235
1996	0.113	0.227	0.537	1.000	0.525	0.235
1997	0.113	0.227	0.537	1.000	0.525	0.235
1998	0.113	0.227	0.537	1.000	0.525	0.235
1999	0.113	0.227	0.537	1.000	0.525	0.235
2000	0.113	0.227	0.537	1.000	0.525	0.235
2001	0.113	0.227	0.537	1.000	0.525	0.235
2002	0.113	0.227	0.537	1.000	0.525	0.235
2003	0.113	0.227	0.537	1.000	0.525	0.235
2004	0.113	0.227	0.537	1.000	0.525	0.235

7.3 Commercial HL

Lognormal dist.
average biomass
Ages 0 - 5
log-likelihood = 8.64
deviance = 14.13
Chi-sq. discrepancy= 14.01

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	-0.220	0.333	-0.553	0.293	0.211E-06	0.264	0.458	2.253
1994	-0.247	0.074	-0.321	0.280	0.211E-06	0.257	0.354	1.121
1995	-0.007	-0.023	0.016	0.271	0.211E-06	0.326	0.321	0.006
1996	-0.402	-0.057	-0.346	0.289	0.211E-06	0.220	0.310	1.182
1997	-0.165	-0.206	0.042	0.268	0.211E-06	0.279	0.267	0.000
1998	-0.254	-0.246	-0.007	0.283	0.211E-06	0.255	0.257	0.026
1999	-0.290	-0.170	-0.119	0.287	0.211E-06	0.246	0.277	0.256
2000	-0.101	0.091	-0.192	0.276	0.211E-06	0.297	0.360	0.533
2001	-0.028	0.022	-0.050	0.271	0.211E-06	0.319	0.336	0.090
2002	0.442	0.039	0.403	0.242	0.211E-06	0.511	0.342	3.402
2003	0.540	0.270	0.270	0.233	0.211E-06	0.564	0.430	1.348
2004	0.730	0.289	0.441	0.255	0.211E-06	0.682	0.439	3.789

Selectivities by age

Year	0	1	2	3	4	5
1993	0.054	0.198	0.187	0.414	0.856	1.000
1994	0.054	0.198	0.187	0.414	0.856	1.000
1995	0.054	0.198	0.187	0.414	0.856	1.000
1996	0.054	0.198	0.187	0.414	0.856	1.000
1997	0.054	0.198	0.187	0.414	0.856	1.000
1998	0.054	0.198	0.187	0.414	0.856	1.000
1999	0.054	0.198	0.187	0.414	0.856	1.000
2000	0.054	0.198	0.187	0.414	0.856	1.000
2001	0.054	0.198	0.187	0.414	0.856	1.000
2002	0.054	0.198	0.187	0.414	0.856	1.000
2003	0.054	0.198	0.187	0.414	0.856	1.000
2004	0.054	0.198	0.187	0.414	0.856	1.000

7.4 Commercial LL

Not used

7.5 SEAMAP Reef Fish

Not used
==

TABLE 8. FISHING MORTALITY RATE FOR OPTION 4 (Preferred Case)

	0	1	2	3	4	5
1987	0.173	0.487	0.545	0.453	0.428	0.428
1988	0.163	0.694	0.571	0.286	0.333	0.333
1989	0.152	0.687	0.752	0.799	0.736	0.736
1990	0.046	0.1	0.232	0.427	0.435	0.435
1991	0.069	0.149	0.739	0.613	0.587	0.587
1992	0.053	0.118	0.65	0.408	0.453	0.453
1993	0.063	0.177	0.494	1.112	0.735	0.735
1994	0.06	0.159	0.555	0.651	0.869	0.869
1995	0.143	0.142	0.456	0.403	0.667	0.667
1996	0.05	0.274	0.819	0.502	0.696	0.696
1997	0.067	0.152	0.467	0.494	0.44	0.44
1998	0.089	0.156	0.359	0.605	0.443	0.443
1999	0.041	0.141	0.378	0.149	0.421	0.421
2000	0.05	0.12	0.62	0.619	0.394	0.394
2001	0.225	0.252	0.669	0.338	0.473	0.473
2002	0.154	0.167	0.504	0.435	0.427	0.427
2003	0.161	0.219	0.624	0.305	0.577	0.577
2004	0.136	0.177	0.522	0.457	0.379	0.379

TABLE 9. ABUNDANCE AT THE BEGINNING OF THE YEAR FOR OPTION 4 (Preferred Case)

	0	1	2	3	4	5
1987	887842	805169	280014	162426	68143	91036
1988	766157	581618	385355	126474	80397	80837
1989	806527	506964	226377	169476	73978	90003
1990	819361	539366	198660	83075	59367	61198
1991	551773	609600	379948	122687	42219	60752
1992	493885	401015	409235	141301	51784	44589
1993	423445	364849	277500	166340	73150	47711
1994	468538	309704	238020	131897	42622	45148
1995	231079	343550	205699	106433	53597	28668
1996	289690	155921	232107	101586	55417	32877
1997	336942	214606	92343	79682	47875	34278
1998	349518	245461	143601	45091	37855	41220
1999	656885	249146	163624	78081	19175	39551
2000	1038722	490947	168548	87336	52380	30031
2001	1030468	769462	339224	70584	36629	43284
2002	727552	641053	465895	135365	39203	38771
2003	669971	485834	422462	219221	68259	39622
2004	573170	444337	304044	176309	125887	47191
2005		389750	289791	140519	86954	92228

TABLE 10. CATCH-AT-AGE USED FOR OPTION 4 (Preferred Case)

	0	1	2	3	4	5
1987	125230	277383	105245	52868	21164	28274
1988	102275	261124	150179	28024	20288	20399
1989	101156	226032	107564	83867	34608	42105
1990	32434	45666	36565	25766	18710	19287
1991	32658	74672	178331	50353	16787	24156
1992	22508	39647	175442	42273	16850	14509
1993	22836	52596	96665	101003	34190	22300
1994	24285	40463	90713	56562	22288	23609
1995	27397	40395	67221	31474	23407	12520
1996	12516	33236	116783	35862	24945	14799
1997	19282	26823	30772	27778	15207	10888
1998	26245	31391	38636	18339	12093	13168
1999	23462	29041	45909	9607	5877	12122
2000	44919	49117	69827	36118	15213	8722
2001	184311	152308	148384	18040	12340	14582
2002	92070	87545	164871	42603	12162	12028
2003	88269	84824	175732	51269	26789	15550
2004	64525	64152	110559	57753	35450	13289

TABLE 11. SPAWNING STOCK FECUNDITY AND RECRUITMENT FOR OPTION 4 (Preferred Case)

year	spawning biomass	recruits from VPA
1987	5886.	887842.
1988	5786.	766157.
1989	5291.	806527.
1990	4052.	819361.
1991	3712.	551773.
1992	3767.	493885.
1993	3851.	423445.
1994	3017.	468538.
1995	2812.	231079.
1996	2882.	289690.
1997	2835.	336942.
1998	2564.	349518.
1999	2470.	656885.
2000	2857.	1038722.
2001	2825.	1030468.
2002	3258.	727552.
2003	4515.	669971.
2004	5877.	573170.

TABLE 12. FITS TO INDEX DATA FOR OPTION 4 (Preferred Case)

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12.1 MRFSS RR

Lognormal dist.
average numbers
Ages 0 - 5
log-likelihood = -26.79
deviance = 111.88
Chi-sq. discrepancy= 240.97

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.948	0.316	0.632	0.198	0.240E-06	0.289	0.154	17.813
1988	0.495	0.285	0.210	0.198	0.240E-06	0.184	0.149	1.100
1989	1.346	0.044	1.302	0.198	0.240E-06	0.431	0.117	169.585
1990	-0.498	0.093	-0.591	0.198	0.240E-06	0.068	0.123	5.221
1991	0.819	0.212	0.607	0.198	0.240E-06	0.254	0.139	15.947
1992	0.666	0.179	0.487	0.198	0.240E-06	0.218	0.134	8.857
1993	0.156	-0.023	0.179	0.198	0.240E-06	0.131	0.110	0.745
1994	-0.088	-0.150	0.062	0.198	0.240E-06	0.103	0.097	0.047
1995	-0.468	-0.276	-0.192	0.198	0.240E-06	0.070	0.085	0.911
1996	-0.536	-0.433	-0.103	0.198	0.240E-06	0.066	0.073	0.334
1997	-0.903	-0.660	-0.244	0.198	0.240E-06	0.045	0.058	1.338
1998	-1.014	-0.537	-0.477	0.198	0.240E-06	0.041	0.066	3.830
1999	-0.705	-0.282	-0.423	0.198	0.240E-06	0.055	0.085	3.199
2000	-0.331	0.010	-0.341	0.198	0.240E-06	0.081	0.113	2.289
2001	-0.258	0.292	-0.550	0.198	0.240E-06	0.087	0.150	4.719
2002	0.447	0.401	0.046	0.198	0.240E-06	0.175	0.167	0.018
2003	0.308	0.341	-0.033	0.198	0.240E-06	0.153	0.158	0.065
2004	-0.382	0.188	-0.570	0.198	0.240E-06	0.077	0.135	4.956

Selectivities by age

Year	0	1	2	3	4	5
1987	0.172	0.327	1.000	0.705	0.500	0.451
1988	0.172	0.327	1.000	0.705	0.500	0.451
1989	0.172	0.327	1.000	0.705	0.500	0.451
1990	0.172	0.327	1.000	0.705	0.500	0.451
1991	0.172	0.327	1.000	0.705	0.500	0.451
1992	0.172	0.327	1.000	0.705	0.500	0.451
1993	0.172	0.327	1.000	0.705	0.500	0.451
1994	0.172	0.327	1.000	0.705	0.500	0.451
1995	0.172	0.327	1.000	0.705	0.500	0.451
1996	0.172	0.327	1.000	0.705	0.500	0.451
1997	0.172	0.327	1.000	0.705	0.500	0.451
1998	0.172	0.327	1.000	0.705	0.500	0.451
1999	0.172	0.327	1.000	0.705	0.500	0.451
2000	0.172	0.327	1.000	0.705	0.500	0.451
2001	0.172	0.327	1.000	0.705	0.500	0.451
2002	0.172	0.327	1.000	0.705	0.500	0.451
2003	0.172	0.327	1.000	0.705	0.500	0.451
2004	0.172	0.327	1.000	0.705	0.500	0.451

12.2 HEADBOAT RR

Lognormal dist.
average numbers
Ages 0 - 5
log-likelihood = -59.11
deviance = 176.51
Chi-sq. discrepancy= 239.41

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1987	0.370	1.262	-0.892	0.198	0.182E-06	0.092	0.223	8.948
1988	0.440	0.783	-0.343	0.198	0.182E-06	0.098	0.138	2.318
1989	0.747	0.959	-0.212	0.198	0.182E-06	0.133	0.165	1.067
1990	-0.130	1.252	-1.382	0.198	0.182E-06	0.056	0.221	14.204
1991	-0.358	0.262	-0.620	0.198	0.182E-06	0.044	0.082	5.577
1992	-0.217	-0.035	-0.182	0.198	0.182E-06	0.051	0.061	0.835
1993	-0.570	0.096	-0.665	0.198	0.182E-06	0.036	0.070	6.149
1994	-0.604	-0.331	-0.274	0.198	0.182E-06	0.035	0.045	1.616
1995	-0.122	-0.254	0.131	0.198	0.182E-06	0.056	0.049	0.348
1996	-0.466	-0.572	0.106	0.198	0.182E-06	0.040	0.036	0.203
1997	-0.494	-0.849	0.356	0.198	0.182E-06	0.039	0.027	3.987
1998	-0.359	-1.061	0.702	0.198	0.182E-06	0.044	0.022	23.944
1999	-0.389	-0.670	0.281	0.198	0.182E-06	0.043	0.032	2.230
2000	-0.147	-0.466	0.319	0.198	0.182E-06	0.055	0.040	3.037
2001	0.373	-0.056	0.429	0.198	0.182E-06	0.092	0.060	6.416
2002	0.623	-0.566	1.189	0.198	0.182E-06	0.118	0.036	123.071
2003	0.542	0.272	0.270	0.198	0.182E-06	0.109	0.083	2.024
2004	0.762	-0.026	0.788	0.198	0.182E-06	0.135	0.062	33.435

Selectivities by age

Year	0	1	2	3	4	5
1987	0.647	0.833	1.000	0.567	0.203	0.196
1988	0.337	1.000	0.480	0.305	0.108	0.126
1989	1.000	0.273	0.635	0.416	0.152	0.153
1990	0.939	0.597	0.970	0.904	1.000	0.538
1991	0.161	0.179	1.000	0.192	0.897	0.048
1992	0.073	0.043	0.629	1.000	0.345	0.095
1993	0.146	0.084	1.000	0.651	0.610	0.665
1994	0.066	0.041	0.744	1.000	0.093	0.039
1995	0.107	0.068	1.000	0.775	0.504	0.177
1996	0.080	0.076	1.000	0.303	0.061	0.000
1997	0.051	0.041	1.000	0.965	0.141	0.056
1998	0.040	0.024	0.582	1.000	0.315	0.057
1999	0.040	0.049	1.000	0.270	0.191	0.094
2000	0.029	0.031	1.000	0.983	0.143	0.174
2001	0.027	0.052	0.881	1.000	0.886	0.066
2002	0.007	0.005	0.232	1.000	0.409	0.156
2003	0.070	0.053	1.000	0.500	0.548	0.181
2004	0.038	0.021	1.000	0.474	0.334	0.264

12.3 Commercial HL

Lognormal dist.
average biomass
Ages 0 - 5
log-likelihood = 14.81
deviance = 9.25
Chi-sq. discrepancy= 8.07

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	-0.220	0.160	-0.380	0.198	0.858E-07	0.264	0.386	2.714
1994	-0.247	-0.086	-0.161	0.198	0.858E-07	0.257	0.301	0.681
1995	-0.007	-0.111	0.104	0.198	0.858E-07	0.326	0.294	0.195
1996	-0.402	-0.204	-0.198	0.198	0.858E-07	0.220	0.268	0.960
1997	-0.165	-0.263	0.099	0.198	0.858E-07	0.279	0.252	0.169
1998	-0.254	-0.236	-0.017	0.198	0.858E-07	0.255	0.259	0.033
1999	-0.290	-0.303	0.014	0.198	0.858E-07	0.246	0.243	0.001
2000	-0.101	-0.133	0.032	0.198	0.858E-07	0.297	0.288	0.004
2001	-0.028	0.065	-0.093	0.198	0.858E-07	0.319	0.351	0.285
2002	0.442	0.268	0.174	0.198	0.858E-07	0.511	0.429	0.698
2003	0.540	0.351	0.189	0.198	0.858E-07	0.564	0.466	0.856
2004	0.730	0.493	0.237	0.198	0.858E-07	0.682	0.538	1.475

Selectivities by age

Year	0	1	2	3	4	5
1993	0.052	0.196	0.193	0.427	0.879	1.000
1994	0.052	0.196	0.193	0.427	0.879	1.000
1995	0.052	0.196	0.193	0.427	0.879	1.000
1996	0.052	0.196	0.193	0.427	0.879	1.000
1997	0.052	0.196	0.193	0.427	0.879	1.000
1998	0.052	0.196	0.193	0.427	0.879	1.000
1999	0.052	0.196	0.193	0.427	0.879	1.000
2000	0.052	0.196	0.193	0.427	0.879	1.000
2001	0.052	0.196	0.193	0.427	0.879	1.000
2002	0.052	0.196	0.193	0.427	0.879	1.000
2003	0.052	0.196	0.193	0.427	0.879	1.000
2004	0.052	0.196	0.193	0.427	0.879	1.000

12.4 Commercial LL

Lognormal dist.
average biomass
Ages 0 - 5
log-likelihood = 15.50
deviance = 7.86
Chi-sq. discrepancy= 8.45

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1993	0.085	0.174	-0.089	0.198	0.998E-06	3.200	3.498	0.264
1994	-0.016	-0.069	0.053	0.198	0.998E-06	2.893	2.743	0.029
1995	0.192	-0.172	0.364	0.198	0.998E-06	3.559	2.473	4.231
1996	0.001	-0.187	0.188	0.198	0.998E-06	2.940	2.437	0.838
1997	-0.252	-0.168	-0.084	0.198	0.998E-06	2.283	2.483	0.243
1998	-0.281	-0.259	-0.022	0.198	0.998E-06	2.219	2.268	0.041
1999	-0.114	-0.184	0.070	0.198	0.998E-06	2.621	2.445	0.066
2000	-0.101	-0.121	0.020	0.198	0.998E-06	2.657	2.604	0.000
2001	-0.028	0.073	-0.101	0.198	0.998E-06	2.856	3.161	0.325
2002	-0.078	0.181	-0.259	0.198	0.998E-06	2.717	3.521	1.480
2003	0.329	0.277	0.052	0.198	0.998E-06	4.084	3.876	0.027
2004	0.264	0.456	-0.192	0.198	0.998E-06	3.825	4.634	0.908

Selectivities by age

Year	0	1	2	3	4	5
1993	0.037	0.135	0.131	0.252	0.498	1.000
1994	0.037	0.135	0.131	0.252	0.498	1.000
1995	0.037	0.135	0.131	0.252	0.498	1.000
1996	0.037	0.135	0.131	0.252	0.498	1.000
1997	0.037	0.135	0.131	0.252	0.498	1.000
1998	0.037	0.135	0.131	0.252	0.498	1.000
1999	0.037	0.135	0.131	0.252	0.498	1.000
2000	0.037	0.135	0.131	0.252	0.498	1.000
2001	0.037	0.135	0.131	0.252	0.498	1.000
2002	0.037	0.135	0.131	0.252	0.498	1.000
2003	0.037	0.135	0.131	0.252	0.498	1.000
2004	0.037	0.135	0.131	0.252	0.498	1.000

12.5 SEAMAP Reef Fish

Lognormal dist.
average numbers
Ages 0 - 5
log-likelihood = -68.35
deviance = 165.85
Chi-sq. discrepancy= 260.25

Year	Observed	Predicted	Residuals (Obs-pred)	Standard Deviation	Q Catchabil.	Untransfrmd Observed	Untransfrmd Predicted	Chi-square Discrepancy
1992	1.525	0.151	1.374	0.198	0.409E-06	1.946	0.493	206.512
1993	-1.037	-0.011	-1.026	0.198	0.409E-06	0.150	0.419	10.520
1994	0.462	-0.075	0.538	0.198	0.409E-06	0.672	0.393	11.519
1995	-0.112	-0.316	0.204	0.198	0.409E-06	0.379	0.309	1.027
1996	-0.126	-0.477	0.350	0.198	0.409E-06	0.373	0.263	3.845
1997	0.021	-0.470	0.491	0.198	0.409E-06	0.433	0.265	9.088
2001	0.341	0.529	-0.188	0.198	0.409E-06	0.595	0.719	0.882
2002	-1.244	0.438	-1.682	0.198	0.409E-06	0.122	0.656	16.712
2004	0.170	0.231	-0.061	0.198	0.409E-06	0.502	0.533	0.149

Selectivities by age

Year	0	1	2	3	4	5
1992	1.000	1.000	1.000	1.000	1.000	1.000
1993	1.000	1.000	1.000	1.000	1.000	1.000
1994	1.000	1.000	1.000	1.000	1.000	1.000
1995	1.000	1.000	1.000	1.000	1.000	1.000
1996	1.000	1.000	1.000	1.000	1.000	1.000
1997	1.000	1.000	1.000	1.000	1.000	1.000
2001	1.000	1.000	1.000	1.000	1.000	1.000
2002	1.000	1.000	1.000	1.000	1.000	1.000
2004	1.000	1.000	1.000	1.000	1.000	1.000

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TABLE 13a: Continuity Case Benchmarks

ref:	F2004	Fmax	F0.1	F20%	F30%	F40%
	0.669	0.285	0.170	0.279	0.196	0.142
F2004/ref	1	2.34	3.93	2.39	3.41	4.70
Fcurrent	0.605					
Fcurrent/ref	1	2.12	3.55	2.16	3.08	4.25
ref:	SSB2004	SSBmax	SSB0.1	SSB20%	SSB30%	SSB40%
	5219	8729	15350	8972	13410	17870
SSB2004/ref	1	0.60	0.34	0.58	0.39	0.29

TABLE 13b: Option 4 Benchmarks (Preferred Case)

ref:	F2004	Fmax	F0.1	F20%	F30%	F40%
	0.522	0.330	0.209	0.349	0.247	0.181
F2004/ref	1	1.58	2.50	1.50	2.12	2.89
Fcurrent	0.548					
Fcurrent/ref	1	1.662	2.626	1.571	2.221	3.034
ref:	SSB2004	SSBmax	SSB0.1	SSB20%	SSB30%	SSB40%
	5877	9479	15530	8815	13210	17560
SSB2004/ref	1	0.62	0.38	0.67	0.44	0.33

Table 14a: Projected Yield (lbs), Continuity Case, 2007-2009

		Year		
Scenario	percentile	2007	2008	2009
F30%	10th	290,900	505,200	666,400
	25th	410,500	661,200	907,000
	median	656,600	1,085,000	1,448,000
	75th	1,159,000	1,636,000	2,212,000
	90th	1,920,000	2,516,000	3,100,000
F40%	10th	214,700	387,500	530,300
	25th	302,800	514,500	721,200
	median	487,700	831,700	1,148,000
	75th	856,400	1,260,000	1,751,000
	90th	1,416,000	1,923,000	2,450,000

Table 14b: Projected Yield (lbs), Preferred Case (Option 4) , 2007-2009

		Year		
Scenario	percentile	2007	2008	2009
F30%	10th	362,200	500,900	657,600
	25th	568,500	848,400	1,131,000
	median	1,181,000	1,520,000	1,890,000
	75th	2,239,000	2,511,000	2,913,000
	90th	3,552,000	3,731,000	4,108,000
F40%	10th	271,700	386,700	535,200
	25th	425,100	658,700	913,500
	median	879,200	1,180,000	1,518,000
	75th	1,654,000	1,957,000	2,353,000
	90th	2,619,000	2,895,000	3,287,000

Table 15a: Projected Yield (in thousands of lbs) for Continuity Case						
	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	Median	90th percentile
2007	289	657	1,936	214	488	1,432
2008	495	1,085	2,519	378	832	1,943
2009	662	1,448	3,123	530	1,148	2,472
2010	908	1,899	3,562	747	1,560	2,906
2011	1,287	2,337	4,181	1,054	1,971	3,460
2012	1,665	2,786	4,578	1,409	2,368	3,862
2013	1,981	3,114	5,019	1,717	2,683	4,320
2014	2,211	3,334	5,422	1,930	2,926	4,642
2015	2,380	3,501	5,571	2,089	3,075	4,870
2016	2,579	3,639	5,634	2,318	3,220	5,025
2017	2,661	3,779	5,660	2,392	3,373	5,014
2018	2,767	3,935	5,837	2,490	3,534	5,111
2019	2,751	3,990	5,751	2,516	3,573	5,126
2020	2,817	4,060	5,962	2,608	3,650	5,232
2021	2,919	4,062	5,847	2,679	3,700	5,365
2022	2,945	4,035	5,778	2,744	3,691	5,201
2023	3,004	4,028	5,923	2,762	3,683	5,359
2024	2,984	4,049	5,904	2,804	3,709	5,366
2025	3,019	4,135	5,795	2,781	3,808	5,242
2026	2,875	4,100	5,823	2,740	3,758	5,195

Table 15b: Projected Yield (in thousands of lbs) for Preferred Case (Option 4)						
	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	median	90th percentile
2007	359	1,181	3,635	268	879	2,683
2008	500	1,520	3,737	387	1,180	2,904
2009	650	1,890	4,112	527	1,518	3,312
2010	939	2,181	4,215	801	1,806	3,478
2011	1,327	2,621	4,525	1,134	2,186	3,831
2012	1,631	2,871	4,572	1,406	2,477	3,911
2013	1,850	3,051	4,730	1,603	2,665	4,201
2014	2,054	3,196	4,915	1,811	2,826	4,353
2015	2,158	3,309	4,904	1,936	2,979	4,371
2016	2,227	3,359	4,961	2,014	3,036	4,474
2017	2,341	3,377	5,124	2,147	3,063	4,588
2018	2,433	3,464	5,324	2,234	3,164	4,806
2019	2,415	3,551	5,205	2,239	3,258	4,672
2020	2,458	3,565	5,494	2,297	3,270	4,956
2021	2,491	3,573	5,341	2,306	3,296	4,822
2022	2,486	3,574	5,254	2,341	3,314	4,840
2023	2,572	3,542	5,227	2,404	3,302	4,773
2024	2,631	3,579	5,260	2,438	3,317	4,780
2025	2,629	3,633	5,145	2,452	3,366	4,720
2026	2,570	3,642	5,073	2,426	3,345	4,699

Table 16a: Projected SSB/SSB30, Continuity Case						
	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	Median	90th percentile
2007	0.03	0.09	0.37	0.03	0.09	0.38
2008	0.07	0.15	0.51	0.07	0.17	0.56
2009	0.14	0.31	0.74	0.16	0.35	0.84
2010	0.20	0.46	0.94	0.24	0.53	1.10
2011	0.25	0.56	1.08	0.31	0.67	1.30
2012	0.36	0.69	1.24	0.44	0.84	1.51
2013	0.49	0.84	1.40	0.62	1.03	1.75
2014	0.60	0.93	1.51	0.77	1.16	1.89
2015	0.66	1.01	1.59	0.86	1.28	2.02
2016	0.69	1.06	1.70	0.89	1.36	2.17
2017	0.75	1.09	1.76	0.98	1.42	2.24
2018	0.78	1.12	1.73	1.03	1.46	2.26
2019	0.81	1.16	1.70	1.07	1.53	2.21
2020	0.82	1.18	1.72	1.09	1.56	2.22
2021	0.82	1.21	1.72	1.09	1.59	2.30
2022	0.86	1.21	1.79	1.14	1.61	2.32
2023	0.85	1.19	1.78	1.15	1.60	2.32
2024	0.87	1.19	1.79	1.17	1.58	2.30
2025	0.88	1.20	1.76	1.19	1.59	2.32
2026	0.88	1.20	1.76	1.20	1.60	2.31

Table 16b: Projected SSB/SSB30, Preferred Case (Option 4)						
	F30% scenario			F40% scenario		
	10th percentile	median	90th percentile	10th percentile	median	90th percentile
2007	0.06	0.26	0.98	0.06	0.26	1.01
2008	0.09	0.35	1.12	0.10	0.38	1.20
2009	0.15	0.47	1.20	0.17	0.53	1.35
2010	0.21	0.62	1.30	0.24	0.72	1.53
2011	0.29	0.72	1.38	0.35	0.86	1.66
2012	0.42	0.84	1.40	0.52	1.02	1.72
2013	0.55	0.94	1.47	0.70	1.18	1.84
2014	0.63	1.02	1.56	0.79	1.30	1.97
2015	0.69	1.09	1.59	0.89	1.39	2.04
2016	0.72	1.11	1.71	0.94	1.44	2.15
2017	0.76	1.12	1.77	1.00	1.47	2.28
2018	0.79	1.14	1.74	1.04	1.49	2.26
2019	0.83	1.17	1.72	1.10	1.53	2.23
2020	0.84	1.19	1.73	1.11	1.57	2.26
2021	0.84	1.20	1.73	1.12	1.59	2.27
2022	0.86	1.22	1.80	1.15	1.62	2.33
2023	0.87	1.20	1.77	1.18	1.60	2.28
2024	0.87	1.19	1.76	1.17	1.58	2.30
2025	0.88	1.19	1.75	1.20	1.60	2.31
2026	0.89	1.20	1.74	1.20	1.61	2.30

Table 17a: Projected SSB/SSB40, Continuity Case						
	F30% scenario			F40% scenario		
	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile
2007	0.03	0.07	0.28	0.03	0.07	0.29
2008	0.05	0.12	0.39	0.06	0.12	0.42
2009	0.11	0.23	0.56	0.12	0.26	0.63
2010	0.15	0.34	0.71	0.18	0.40	0.83
2011	0.19	0.42	0.81	0.23	0.50	0.98
2012	0.27	0.52	0.93	0.33	0.64	1.13
2013	0.37	0.63	1.05	0.47	0.77	1.31
2014	0.45	0.69	1.13	0.58	0.87	1.42
2015	0.50	0.76	1.19	0.64	0.96	1.51
2016	0.52	0.80	1.27	0.67	1.02	1.63
2017	0.56	0.82	1.32	0.74	1.06	1.68
2018	0.58	0.84	1.29	0.77	1.09	1.70
2019	0.61	0.88	1.28	0.80	1.15	1.66
2020	0.62	0.89	1.29	0.82	1.17	1.67
2021	0.62	0.91	1.29	0.82	1.19	1.72
2022	0.64	0.91	1.34	0.86	1.21	1.75
2023	0.64	0.90	1.34	0.86	1.20	1.74
2024	0.65	0.89	1.34	0.88	1.19	1.73
2025	0.66	0.90	1.32	0.90	1.19	1.75
2026	0.66	0.90	1.32	0.90	1.21	1.73

Table 17b: Projected SSB/SSB40, Preferred Case (Option 4)						
	F30% scenario			F40% scenario		
	10th percentile	Median	90th percentile	10th percentile	median	90th percentile
2007	0.04	0.20	0.74	0.04	0.20	0.76
2008	0.07	0.27	0.84	0.07	0.28	0.90
2009	0.11	0.35	0.90	0.13	0.40	1.01
2010	0.16	0.47	0.98	0.18	0.54	1.15
2011	0.22	0.54	1.04	0.26	0.65	1.24
2012	0.32	0.63	1.05	0.39	0.77	1.29
2013	0.41	0.70	1.11	0.52	0.88	1.38
2014	0.47	0.76	1.17	0.60	0.98	1.48
2015	0.51	0.82	1.19	0.67	1.05	1.53
2016	0.54	0.83	1.28	0.71	1.08	1.61
2017	0.57	0.85	1.33	0.75	1.10	1.71
2018	0.59	0.86	1.31	0.78	1.12	1.70
2019	0.62	0.88	1.29	0.83	1.15	1.67
2020	0.63	0.90	1.29	0.83	1.18	1.69
2021	0.63	0.90	1.30	0.84	1.19	1.70
2022	0.65	0.91	1.34	0.86	1.21	1.75
2023	0.65	0.90	1.32	0.88	1.20	1.71
2024	0.65	0.90	1.33	0.88	1.19	1.73
2025	0.66	0.90	1.31	0.90	1.20	1.73
2026	0.67	0.90	1.31	0.90	1.21	1.73

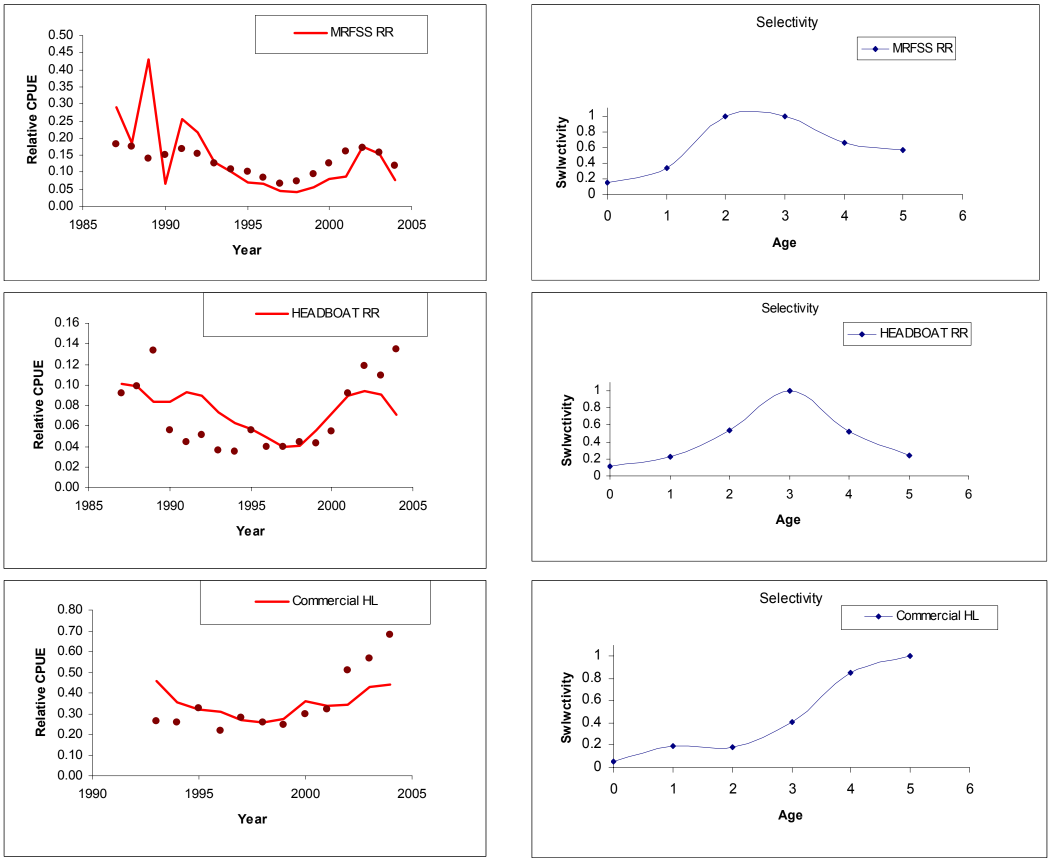


Figure 1: Fits of abundance indices for the Continuity Case (left) and the selectivity patterns (right).

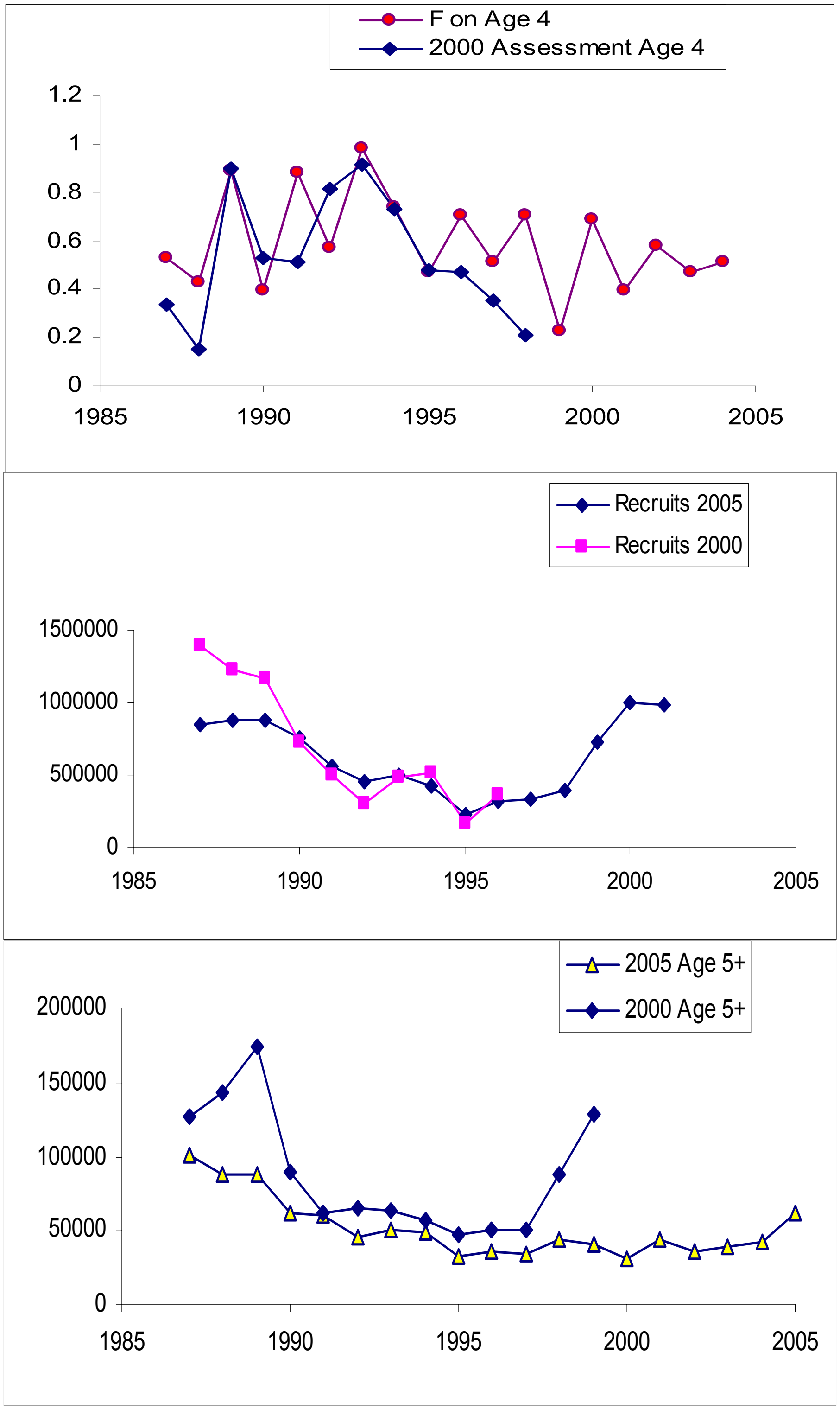


Figure 2: Comparison of selected results from Continuity Case to 2000 assessment.

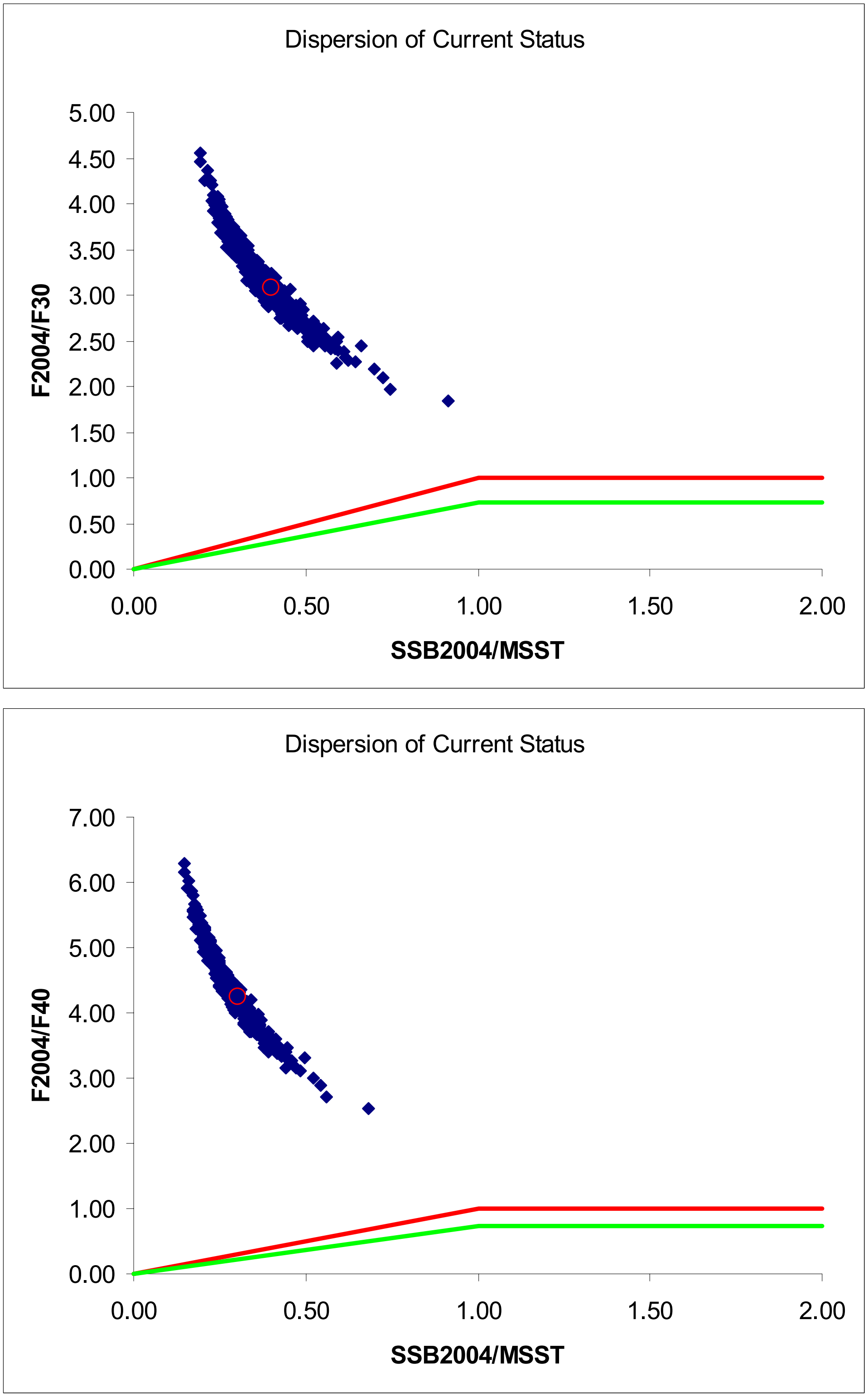
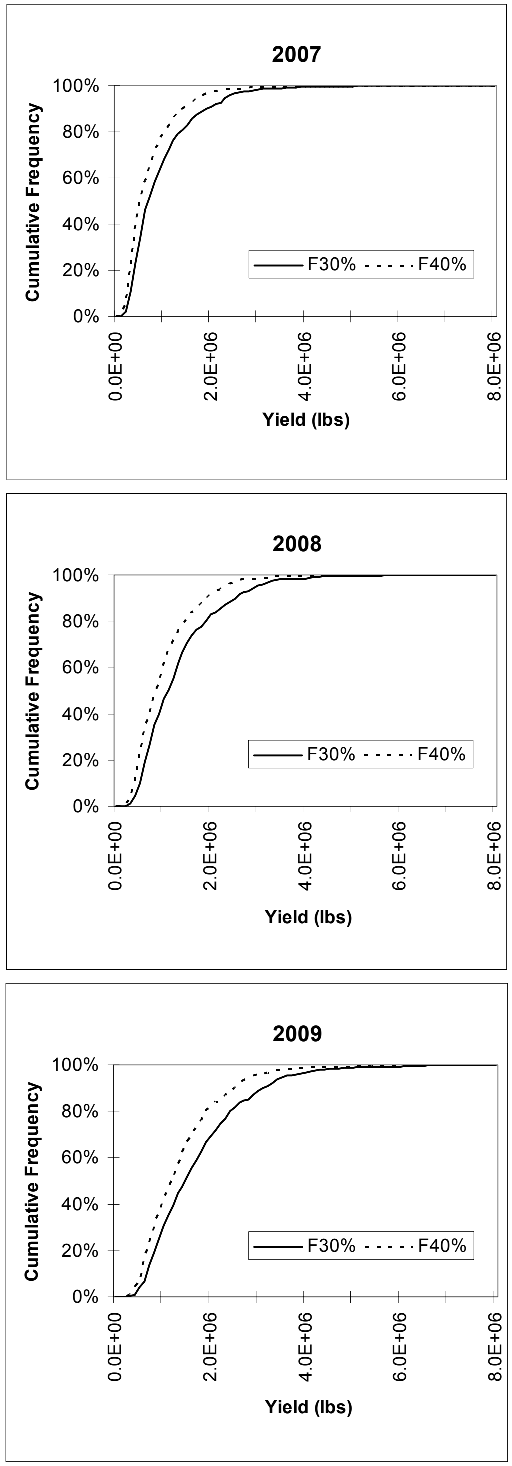


Figure 3: Estimates of stock status in the terminal year based on 501 bootstrap results for the Continuity Case. Open red circle represents the deterministic outcome. The solid red line represents an MFMT control rule and the solid green line represents an OY target control rule.

Figure 4: Cumulative frequency distribution of predicted future yields from the Continuity Case VPA results under F30% and F40% for 2007, 2008 and 2009.



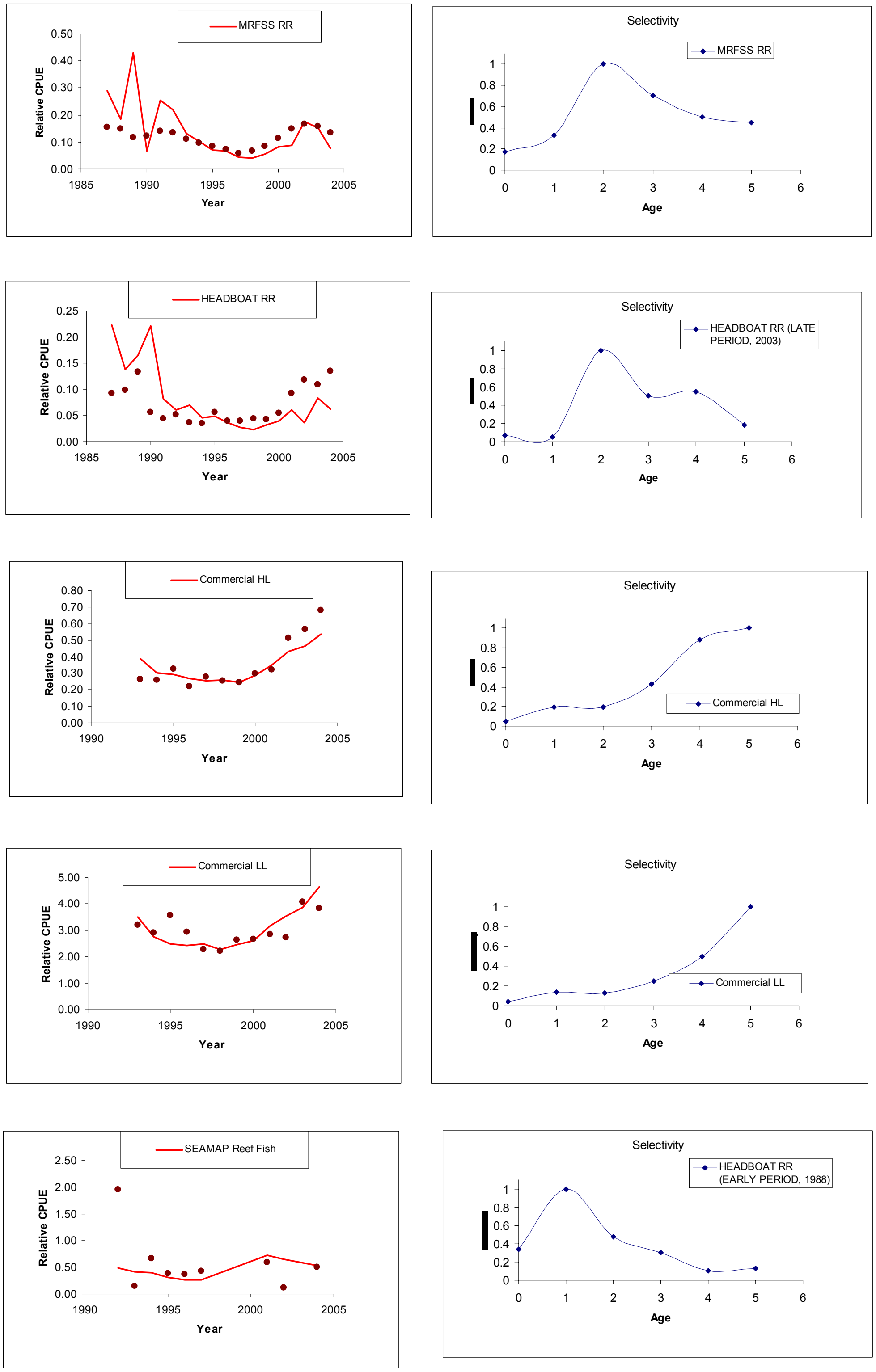


Figure 5: Fits of abundance indices for Option 4 (left) and the selectivity patterns (right). NOTE: The graph in the lower right is not the selectivity pattern for the SEAMAP index (which was assumed to be evenly selected across ages), but rather it is the headboat selectivity pattern in 1988.

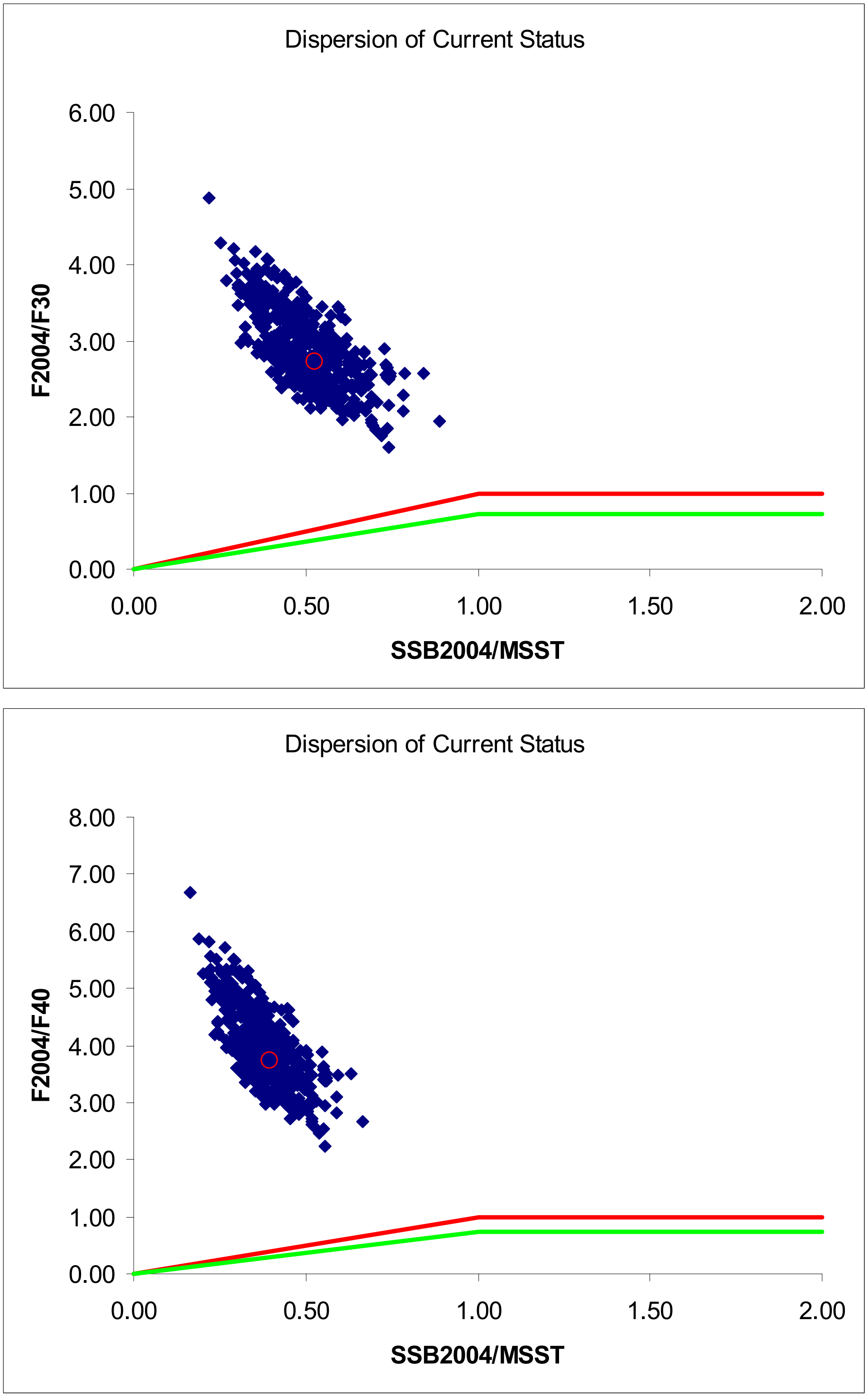


Figure 6: Estimates of stock status in the terminal year based on 501 bootstrap results for Option 4 (the preferred case). Open red circle represents the deterministic outcome. The solid red line represents an MFMT control rule and the solid green line represents an OY target control rule.

Figure 7: Cumulative frequency distribution of predicted future yields from the preferred case (Option 4) VPA results under F30% and F40% for 2007, 2008 and 2009.