

Revision and Update of the Stock Assessment Analyses on Atlantic King Mackerel 2003

SEDAR 5 Assessment Workshop 2004

Not to be distributed without accompanying Panel Report

by
Sustainable Fisheries Division

February 2004

National Marine Fisheries Service
Southeast Fisheries Science Center
Sustainable Fisheries Division
75 Virginia Beach Drive
Miami, FL 33149

Sustainable Fisheries Division Contribution SFD/2004-000#

During the MSAP 2003 meeting (Ref) the panel recommended the revision and update of the protocols for evaluating uncertainty of stock evaluation, specifically for Atlantic king mackerel 2003 Stock Assessment. During subsequent review it was noticed that some of the bootstraps for Atlantic King stock analyses were providing unreasonable solutions, as indicated by the extreme high estimates of fishing mortality. At the 2003 MSAP meeting, and *ad hoc* solution was adopted to include only those bootstrap runs were ratios of spawning stock biomass over spawning biomass at MSY were less than 3.0 for the last year of the VPA ($SS_{2002-03}/SS_{MSY} < 3.0$).

Further review of the FADAPT-VPA results in preparations for SEDAR-AW indicated that on the anomalous bootstraps the minimization procedure failed to converge in the estimation of F at age-year, and instead would diverge from an initial estimate towards unreasonably high F values, usually at an upper limit boundary value. Modifications were implemented in the FADAPT bisection algorithm to ensure that diverging solutions were not accepted. Also, some additional checking procedures were adopted to confirm that the solution F matrix and stock size were consistent with the initial Catch-at-age (CAA) input matrix.

After testing and evaluating the program changes, the stock analyses for Atlantic king 2003 assessment were run again. VPA analyses were carry out using exactly the same inputs, model specifications, and initial conditions as those presented at the MSAP meeting in 2003, see MSAP/03/01 (2003) for further details of VPA model specifications. This report presents the updated estimates for Atlantic king mackerel results. Two models were run for Atlantic king stock in 2003, a base model that followed the similar specifications and indices of abundance as in the prior assessment (1998), estimating eight fishing mortality rates in the last year for ages 2 to 9, and with fixed F ratios for F_0 , F_1 , F_{10} and F_{11+} groups. F ratios were defined as: $F_0/F_2 = 0.0108$, $F_1/F_2 = 0.4716$, $F_{10}/F_9 = 1.0$, and $F_{11+}/F_9 = 1.0$. The second VPA model included an additional index of abundance, from the North Carolina Commercial fisheries (Trip Ticket Program), but otherwise using the same initial conditions as the base model.

During the MSAP 2003 assessment the Working Group selected as final model for king Atlantic stock status determination a modified VPA base model, with Ages 1 though 11+, and using a stock recruit

relationship base on recruits Age 1 (See MSAP 2003 Report). The final model estimates and benchmarks were also updated

The next section presents the tables of the original report (MSAP 2003/01) (labeled Old values as presented in MSAP 2003) and their corresponding updated table values (labeled New Updated values 2004). Tables 14 and 14A, show the estimates of Stock Size and F at age from the deterministic run of the base model for original values and the updated ones, respectively. Tables 15 and 15A show the estimates of Stock size and F at age from the deterministic run of the Full index model for original values and the updated 2004 values, respectively. Table F-1 presents the estimates of Stock size and F at age from the deterministic run of the final model selected by the MSAP 2003. Tables 16 and 16A present the MSY and OY related benchmark estimates from the base model and the full index model, original report and updated 2004 values, respectively. Tables 17 and 17A present corresponding estimates of ABC from the base and full index model, original report and updated 2004 values, respectively. Table F-2 presents the corresponding MSY and OY related benchmark values from the final selected by the MSAP 2003. Table F-3 shows the 2004 updated estimates for ABC from the final model selected by the MSAP 2003.

Figures 26, 27, 28 and 29 from the MSAP 2003/01 document were also updated (labeled Updated value MSAP/03/1). Finally, Figures from the 2003 MSAP Report were revised and updated (labeled MSAP 2003 Report Updated figure).

Finally, the following values were updated in the Summary of recommendations for 2003/04 table of the 2003 MSAP Report. Updates did not change the projected status or the conclusions of stock status for the Atlantic king mackerel stock.

SUMMARY OF RECOMMENDATIONS FOR 2003/04

GROUP	Description	Value	Projected Status
King mackerel: Atlantic migratory group	ABC (Range) @ F_{OY}^a	5.8 5.2 (4.5 3.8 - 7.8 7.5)	
	MSY ^b (Range)	5.7 5.0 (2.6 4.3 - 8.3 9.1)	
	Percentage of $F_{2002/03} >$	1% 4%	not overfishing ^c
	Percentage of $B_{2003} < MSST$	2% 7%	not overfished ^d
Spanish mackerel: Atlantic migratory group	ABC (Range) @ F_{OY}^a	6.7 (5.2 - 8.4) million lbs	
	MSY ^b (Range)	5.2 (4.4 - 6.4) million lbs	
	Percentage of $F_{2002/03} >$	4%	not overfishing ^c
	Percentage of $B_{2003} < MSST$	< 1%	not overfished ^d
Spanish mackerel: Gulf migratory group	ABC @ F_{OY}^a	6.3 (4.1 - 9.2) million lbs	
	ABC (Range) @ $F_{30\%SPR}^c$	9.0 (6.0 - 12.8) million	
	MSY ^b (Range)	7.1 (5.5 - 9.2) million lbs	
	Percentage of $F_{2002/03} >$	9%	not overfishing ^c
	Percentage of $B_{2003} < MSST$	3%	not overfished ^d

a. Acceptable biological catch (ABC) is recommended as the median probability of achieving the management target (yield at F_{OY}). The range given is yield corresponding to between the 20% and 80% probabilities of achieving F_{OY} (specified as $F_{40\%SPR}$ by both Councils) from the 2003 base virtual population analysis (VPA) model.

- b. Maximum sustainable yield (MSY) is the maximum long-term yield when a stock is at equilibrium. Given are the median estimate of MSY and the 20th to 80th percentile range of estimated MSY from the 2003 assessment's base model.
- c. The MSAP defines overfishing as occurring when current F has greater than a 50% probability of exceeding MFMT.
- d. The MSAP defines overfished as the condition when current biomass (B) has greater than a 50% probability of being less than MSST.
- e. The MSAP's recommendation for ABC for this migratory group is the median probability of achieving $F_{40\%SPR}$, but the median probability of not exceeding $F_{30\%SPR}$ is also provided as the upper limit of ABC defined by the GMFMC.

Table 14. (Old values as presented in MSAP 2003) Atlantic king mackerel tuned VPA results for model Base

Stock at Age at beginning of year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	1047031	1104831	1388353	1843286	2304339	1804701	958103	1264311	2982773	1922082	1005473	1016905	1223194	1427967
1	1198602	900642	948333	1191544	1585442	1982327	1551985	818946	1086574	2566373	1653788	865194	874752	1051811
2	1863727	1026220	770075	789104	1021711	1284526	1596653	1152790	686903	871248	2084034	1334531	673043	707743
3	1278296	1590839	877947	607019	669848	762356	900448	1178121	791207	497186	599421	1496660	908863	500515
4	1371725	1048409	1350108	662636	504260	552858	549167	645655	835951	553470	355254	420023	1029451	662795
5	1055530	1038041	835670	1097084	475812	374038	345275	384779	451034	628015	391970	240745	295965	783842
6	803328	787150	736198	591265	819214	318224	263042	229041	275659	324225	465109	245235	166815	224774
7	810080	597451	521982	566259	398819	581810	215761	188666	140841	195440	223524	323069	162655	111830
8	302630	572697	363686	330341	354482	188502	414931	154457	104684	91937	143680	149960	235273	108560
9	2036308	211930	350208	186733	234373	120628	109746	335820	112209	74622	64711	95164	111536	163380
10	275943	9219	157263	237717	98819	146958	87295	81588	245570	87496	39189	44619	64940	78831
11+	356691	499735	326059	327388	359503	315261	320047	299228	236350	338683	301648	228396	166145	139963

	95	96	97	98	99	100	101	102
0	2261274	1835061	1073102	3010244	1067260	322267	1	0
1	1229060	1946242	1578573	921016	2583952	917228	276555	1
2	821575	953472	1626468	1272232	738543	2148777	773156	222801
3	479119	569389	650082	1138512	930707	538557	1591792	578390
4	371415	330292	363982	435665	811670	672455	371428	1245712
5	500803	271453	198279	235812	281981	580373	429305	258928
6	592331	374500	176229	121983	144224	189866	417751	290325
7	154246	439842	290805	124344	72459	96720	127532	317130
8	82028	113922	319626	212863	88735	51633	70726	91993
9	74147	53459	74660	237369	158189	66144	35285	52921
10	110776	45196	33409	49017	179634	119862	48237	25196
11+	154131	186431	171272	146930	143080	251919	270624	227684

F at Age during year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	0.0006	0.0027	0.0029	0.0007	0.0005	0.0009	0.0069	0.0015	0.0004	0.0003	0.0003	0.0006	0.001	0
1	0.0053	0.0066	0.0338	0.0038	0.0605	0.0664	0.1474	0.0258	0.0709	0.0582	0.0645	0.1011	0.0619	0.097
2	0.0083	0.0061	0.0879	0.0138	0.1428	0.2053	0.154	0.2264	0.1732	0.224	0.1811	0.2341	0.1462	0.2401
3	0.0483	0.0141	0.1314	0.0355	0.042	0.178	0.1826	0.1931	0.2074	0.1861	0.2057	0.2242	0.1657	0.1483
4	0.1287	0.0768	0.0575	0.1812	0.1487	0.3208	0.2057	0.2087	0.136	0.195	0.2391	0.2001	0.1226	0.1303
5	0.1434	0.1936	0.196	0.1421	0.2523	0.202	0.2604	0.1835	0.1801	0.1503	0.319	0.2169	0.1251	0.1301
6	0.1461	0.2608	0.1124	0.2438	0.1922	0.2386	0.1823	0.3363	0.1939	0.2219	0.2144	0.2606	0.2499	0.2265
7	0.1968	0.3464	0.3075	0.3184	0.5994	0.188	0.1843	0.439	0.2765	0.1577	0.2492	0.1671	0.2543	0.1599
8	0.2063	0.3418	0.5166	0.1932	0.9279	0.3909	0.0615	0.1695	0.1885	0.2012	0.262	0.146	0.2147	0.2313
9	5.2476	0.1483	0.2374	0.4864	0.3168	0.1734	0.1465	0.163	0.0988	0.494	0.2218	0.2321	0.197	0.2386
10	0.0858	0.2953	0.2395	0.3023	0.2242	0.2176	0.1584	0.327	0.2027	0.1956	0.2503	0.3467	0.3514	0.2003
11+	0.0858	0.2953	0.2395	0.3023	0.2242	0.2176	0.1584	0.327	0.2027	0.1956	0.2503	0.3467	0.3514	0.2003

	95	96	97	98	99	100	101
0	0	0.0006	0.0028	0.0027	0.0015	0.003	0.0015
1	0.1039	0.0295	0.0657	0.0708	0.0344	0.0209	0.0661
2	0.2167	0.233	0.2067	0.1626	0.1658	0.15	0.1402
3	0.222	0.2975	0.2502	0.1884	0.175	0.2215	0.0952
4	0.1635	0.3603	0.2841	0.285	0.1854	0.2988	0.2108
5	0.1406	0.282	0.3358	0.3417	0.2455	0.1788	0.2412
6	0.1476	0.1029	0.1987	0.3709	0.2495	0.2479	0.1256
7	0.153	0.1693	0.162	0.1874	0.1889	0.163	0.1767
8	0.2781	0.2726	0.1475	0.1469	0.1438	0.2307	0.14
9	0.345	0.3201	0.2708	0.1287	0.1275	0.1657	0.1868
10	0.2013	0.1519	0.1815	0.1644	0.0977	0.1676	0.1868
11+	0.2013	0.1519	0.1815	0.1644	0.0977	0.1676	0.1868

Table 14-A. (New Updated values 2004) Atlantic king mackerel tuned VPA results for model Base,

Stock at Age at beginning of year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	1043015	1098972	1376331	1822578	2268822	1786924	942835	1237486	2867193	1837069	964988	991314	1198012	1043015
1	1192279	897186	943290	1181197	1567618	1951758	1536684	805805	1063485	2466891	1580616	830348	852726	1192279
2	1851267	1020778	767100	784764	1012805	1269186	1570343	1139624	675593	851376	1998413	1271555	643054	1851267
3	1275707	1580115	873263	604458	666112	754693	887252	1155482	779882	487455	582329	1422997	854698	1275707
4	1369679	1046180	1340878	658605	502056	549642	542574	634301	816475	543728	346882	405319	966091	1369679
5	1053165	1036280	833752	1089140	472344	372142	342511	379107	441267	611256	383589	233544	283316	1053165
6	802229	785115	734683	589615	812378	315241	261411	226664	270779	315822	450689	238031	160621	802229
7	808405	596506	520232	564955	397399	575929	213196	187262	138798	191242	216296	310664	156459	808405
8	301880	571256	362873	328836	353361	187286	409872	152250	103479	90180	140068	143744	224601	301880
9	87654	211285	348970	186036	233079	119673	108701	331466	110310	73585	63200	92058	106187	87654
10	275277	9195	156708	236652	98221	145846	86474	80689	241824	85862	38299	43319	62269	275277
11+	355831	498421	324908	325921	357326	312874	317037	295931	232744	332357	294800	221742	159310	355831

	95	96	97	98	99	100	101	102
0	1384382	1847118	2943055	1049749	3155667	1117498	338311	1
1	1030137	1191546	1589775	2532233	900917	2709118	960469	290364
2	688785	802922	921187	1319658	2093026	721245	2256507	810373
3	474711	462815	553343	622314	874616	1637034	523673	1684492
4	616192	349212	316267	350187	411785	584668	1280269	358625
5	729318	460700	252350	186228	223951	261450	385111	952172
6	213890	545412	339993	159804	111626	134032	172209	249793
7	106503	144884	399471	261108	110214	63563	87955	112348
8	103232	77444	105866	284892	187313	76580	43979	63185
9	154200	69564	49518	67733	207482	136204	55685	28703
10	74229	102880	41259	30022	43061	153916	100944	39238
11+	131793	143145	170188	153908	129077	122596	212159	220140

F at Age during year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	0.0006	0.0028	0.0029	0.0007	0.0005	0.0009	0.007	0.0015	0.0004	0.0004	0.0003	0.0006	0.001	0.0006
1	0.0053	0.0066	0.034	0.0038	0.0612	0.0674	0.1489	0.0263	0.0725	0.0606	0.0676	0.1056	0.0635	0.0053
2	0.0084	0.0061	0.0883	0.0139	0.1442	0.208	0.1568	0.2293	0.1764	0.2298	0.1896	0.2472	0.1535	0.0084
3	0.0484	0.0142	0.1321	0.0356	0.0422	0.18	0.1856	0.1973	0.2107	0.1902	0.2124	0.2373	0.1772	0.0484
4	0.1289	0.077	0.0579	0.1824	0.1494	0.323	0.2085	0.2129	0.1395	0.1989	0.2456	0.2081	0.1311	0.1289
5	0.1437	0.194	0.1965	0.1432	0.2544	0.2032	0.2628	0.1865	0.1845	0.1547	0.3272	0.2243	0.1311	0.1437
6	0.1463	0.2616	0.1127	0.2445	0.194	0.2411	0.1836	0.3405	0.1978	0.2285	0.2221	0.2696	0.2609	0.1463
7	0.1972	0.347	0.3087	0.3193	0.6023	0.1901	0.1867	0.4431	0.2812	0.1614	0.2586	0.1744	0.2658	0.1972
8	0.2068	0.3429	0.5181	0.1942	0.9327	0.394	0.0623	0.1722	0.1909	0.2055	0.2697	0.1528	0.2261	0.2068
9	2.1047	0.1488	0.2384	0.4887	0.3188	0.1749	0.148	0.1653	0.1006	0.503	0.2277	0.241	0.208	2.1047
10	0.086	0.2962	0.2405	0.3039	0.2257	0.2194	0.1601	0.3313	0.2062	0.1997	0.2569	0.3591	0.3695	0.086
11+	0.086	0.2962	0.2405	0.3039	0.2257	0.2194	0.1601	0.3313	0.2062	0.1997	0.2569	0.3591	0.3695	0.086

	95	96	97	98	99	100	101
0	0	0	0.0003	0.0029	0.0026	0.0014	0.0028
1	0.0992	0.1073	0.0362	0.0405	0.0724	0.0328	0.0199
2	0.2476	0.2223	0.2422	0.2613	0.0957	0.1701	0.1424
3	0.157	0.2307	0.3075	0.2629	0.2527	0.0958	0.2286
4	0.1408	0.1749	0.3796	0.297	0.3043	0.2675	0.1461
5	0.1406	0.1538	0.3069	0.3618	0.3634	0.2675	0.2829
6	0.2395	0.1614	0.114	0.2215	0.4131	0.2713	0.2771
7	0.1686	0.1638	0.188	0.1822	0.2141	0.2183	0.1808
8	0.2447	0.2972	0.2966	0.1671	0.1686	0.1686	0.2767
9	0.2547	0.3724	0.3504	0.303	0.1486	0.1496	0.2001
10	0.2141	0.2185	0.1676	0.2041	0.1894	0.1149	0.2023
11+	0.2141	0.2185	0.1676	0.2041	0.1894	0.1149	0.2023

Table 15. (Old Values as presented in 2003 MSAP) Atlantic king mackerel tuned VPA results for Full Index Model.

Stock at Age at beginning of year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	1039593	1093978	1366087	1804932	2238558	1771774	929824	1214626	2768728	1764646	930493	969496	1133051	1324636
1	1186890	894240	938992	1172379	1552430	1925709	1523644	794606	1043810	2382142	1518282	800657	833947	974224
2	1840649	1016140	764564	781064	1005216	1256114	1547924	1128403	665954	834442	1925472	1217907	617503	672624
3	1273500	1570976	869271	602276	662928	748162	876007	1136193	770231	479161	567763	1360246	808559	452725
4	1367934	1044281	1333012	655170	500178	546902	536955	624627	799880	535426	339747	392790	912120	576496
5	1051150	1034779	832118	1082369	469389	370525	340155	374273	432945	596976	376447	227408	272538	682876
6	801292	783381	733391	588209	806552	312700	260021	224638	266621	308662	438402	231892	155343	204615
7	806978	595700	518740	563844	396190	570918	211010	186066	137057	187664	210138	300095	151181	101964
8	301241	570028	362180	327554	352406	186250	405560	150369	102452	88683	136990	138448	215508	98693
9	2328517	210736	347915	185442	231976	118860	107811	327755	108692	72702	61912	89411	101630	146379
10	274709	9175	156235	235745	97711	144898	85774	79923	238631	84469	37541	42212	59992	70309
11+	355097	497301	323928	324671	355472	310840	314472	293122	229671	326967	288965	216072	153486	124833

	95	96	97	98	99	100	101	102
0	2107349	1829852	1028558	2824436	1000334	300892	1	
1	1140122	1813757	1574091	882677	2424025	859625	258157	1
2	754803	876934	1512439	1268373	705547	2011129	723577	206966
3	448915	511955	584254	1040423	927387	510167	1473353	535728
4	330296	304312	314610	379056	727285	669599	347008	1143783
5	426543	236075	175957	193368	233316	507777	426850	237923
6	505450	310603	145814	102801	107760	148018	355296	288213
7	136907	365087	235817	98181	55985	65369	91551	263387
8	73539	99003	255312	165554	66229	37461	43756	61040
9	65660	46161	61833	182032	117484	46780	23100	29717
10	96154	37905	27137	37989	132018	84836	31578	14715
11+	133787	156352	139119	113874	105154	178305	177164	132971

F at Age during year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	0.0006	0.0028	0.0029	0.0007	0.0005	0.0009	0.0071	0.0016	0.0004	0.0004	0.0003	0.0006	0.001	0
1	0.0053	0.0067	0.0341	0.0038	0.0618	0.0684	0.1503	0.0266	0.0739	0.0628	0.0704	0.1097	0.065	0.1052
2	0.0084	0.0061	0.0886	0.014	0.1453	0.2104	0.1592	0.2319	0.1792	0.2351	0.1975	0.2596	0.1604	0.2544
3	0.0484	0.0143	0.1328	0.0358	0.0424	0.1817	0.1882	0.201	0.2136	0.1938	0.2184	0.2496	0.1883	0.1653
4	0.1291	0.0771	0.0583	0.1835	0.15	0.3249	0.2109	0.2165	0.1426	0.2023	0.2515	0.2155	0.1395	0.1513
5	0.144	0.1943	0.1969	0.1441	0.2562	0.2042	0.2649	0.1892	0.1884	0.1587	0.3345	0.2311	0.1366	0.1509
6	0.1465	0.2622	0.1129	0.2452	0.1955	0.2433	0.1847	0.3441	0.2012	0.2345	0.229	0.2778	0.271	0.2518
7	0.1976	0.3476	0.3098	0.32	0.6048	0.192	0.1888	0.4467	0.2853	0.1647	0.2673	0.1811	0.2765	0.1768
8	0.2073	0.3437	0.5194	0.195	0.9368	0.3967	0.063	0.1746	0.193	0.2094	0.2767	0.1592	0.2368	0.2575
9	5.3866	0.1492	0.2392	0.4907	0.3206	0.1762	0.1493	0.1673	0.1021	0.5109	0.233	0.249	0.2184	0.2702
10	0.0862	0.297	0.2413	0.3052	0.227	0.221	0.1615	0.3351	0.2093	0.2033	0.2628	0.3705	0.3866	0.2275
11+	0.0862	0.297	0.2413	0.3052	0.227	0.221	0.1615	0.3351	0.2093	0.2033	0.2628	0.3705	0.3866	0.2275

	95	96	97	98	99	100	101
0	0	0.0006	0.003	0.0029	0.0016	0.0032	0.0016
1	0.1125	0.0317	0.0659	0.074	0.0367	0.0223	0.071
2	0.2382	0.2561	0.2241	0.1631	0.1742	0.1612	0.1506
3	0.2388	0.3369	0.2827	0.2081	0.1757	0.2354	0.1032
4	0.1858	0.3978	0.3367	0.3353	0.2093	0.3002	0.2274
5	0.1672	0.3318	0.3874	0.4347	0.3051	0.2071	0.2427
6	0.1753	0.1255	0.2455	0.4577	0.3499	0.3304	0.1493
7	0.1742	0.2077	0.2038	0.2437	0.2518	0.2514	0.2554
8	0.3157	0.3207	0.1883	0.193	0.1977	0.3335	0.2369
9	0.3994	0.3812	0.3371	0.1712	0.1756	0.243	0.301
10	0.2357	0.1839	0.2284	0.2176	0.1353	0.2456	0.301
11+	0.2357	0.1839	0.2284	0.2176	0.1353	0.2456	0.301

Table 15-A. New Revised values 2004 Atlantic king mackerel tuned VPA results for Full Index Model.

Stock at Age at beginning of year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	1039817	1094305	1366757	1806087	2240539	1772766	930675	1216122	2775173	1769386	932751	970925	1134398	1039817
1	1187243	894433	939274	1172956	1553424	1927414	1524498	795339	1045098	2387689	1522361	802601	835177	1187243
2	1841344	1016444	764730	781306	1005712	1256970	1549392	1129138	666585	835551	1930246	1221418	619176	1841344
3	1273645	1571574	869532	602419	663136	748589	876743	1137455	770863	479704	568717	1364353	811578	1273645
4	1368048	1044405	1333527	655395	500301	547081	537323	625260	800967	535969	340214	393610	915652	1368048
5	1051282	1034877	832225	1082813	469582	370631	340309	374590	433490	597911	376915	227810	273244	1051282
6	801354	783494	733476	588301	806933	312866	260112	224771	266893	309131	439206	232294	155689	801354
7	807071	595753	518838	563917	396269	571246	211153	186144	137171	187899	210541	300787	151526	807071
8	301283	570108	362226	327638	352468	186318	405842	150492	102519	88781	137192	138794	216103	301283
9	87630	210772	347984	185481	232048	118913	107869	327997	108798	72760	61996	89584	101928	87630
10	274746	9176	156266	235804	97744	144960	85820	79973	238840	84560	37591	42284	60141	274746
11+	355145	497374	323992	324753	355593	310973	314640	293306	229872	327320	289347	216443	153867	355145

	95	96	97	98	99	100	101	102
0	1327198	2110497	1831952	1026599	2828249	1001424	301240	1
1	975384	1142327	1816467	1575898	880991	2427307	860563	258456
2	673682	755801	878831	1514771	1269929	704096	2013954	724384
3	454164	449825	512813	585886	1042429	928725	508919	1475784
4	579094	331534	305095	315348	380459	729011	670750	345934
5	685915	428778	237140	176630	194001	234522	509262	427840
6	205222	508065	312526	146729	103379	108304	149055	356573
7	102261	137429	367337	237472	98968	56481	65837	92442
8	98990	73795	99452	257248	166978	66906	37888	44158
9	146890	65916	46380	62219	183698	118709	47362	23466
10	70566	96594	38124	27326	38321	133451	85890	32079
11+	125289	134399	157258	140086	114869	106295	180520	179976

F at Age during year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0	0.0006	0.0028	0.0029	0.0007	0.0005	0.0009	0.0071	0.0016	0.0004	0.0004	0.0003	0.0006	0.001	0.0006
1	0.0053	0.0067	0.0341	0.0038	0.0618	0.0683	0.1502	0.0266	0.0738	0.0627	0.0703	0.1095	0.0649	0.0053
2	0.0084	0.0061	0.0886	0.014	0.1453	0.2102	0.1591	0.2317	0.179	0.2347	0.197	0.2588	0.1599	0.0084
3	0.0484	0.0143	0.1327	0.0357	0.0424	0.1816	0.188	0.2007	0.2134	0.1936	0.218	0.2488	0.1875	0.0484
4	0.1291	0.0771	0.0583	0.1834	0.15	0.3247	0.2108	0.2163	0.1424	0.2021	0.2511	0.215	0.1389	0.1291
5	0.144	0.1942	0.1969	0.1441	0.2561	0.2041	0.2648	0.189	0.1881	0.1585	0.334	0.2307	0.1363	0.144
6	0.1465	0.2622	0.1129	0.2451	0.1954	0.2432	0.1846	0.3439	0.2009	0.2341	0.2286	0.2772	0.2703	0.1465
7	0.1976	0.3476	0.3097	0.3199	0.6046	0.1919	0.1887	0.4465	0.285	0.1645	0.2667	0.1806	0.2757	0.1976
8	0.2073	0.3437	0.5193	0.195	0.9366	0.3965	0.063	0.1744	0.1929	0.2091	0.2762	0.1587	0.2361	0.2073
9	2.1065	0.1492	0.2392	0.4906	0.3205	0.1761	0.1492	0.1672	0.102	0.5104	0.2327	0.2485	0.2177	2.1065
10	0.0862	0.2969	0.2413	0.3051	0.2269	0.2209	0.1614	0.3348	0.2091	0.2031	0.2624	0.3697	0.3854	0.0862
11+	0.0862	0.2969	0.2413	0.3051	0.2269	0.2209	0.1614	0.3348	0.2091	0.2031	0.2624	0.3697	0.3854	0.0862

	95	96	97	98	99	100	101
0	0	0	0.0006	0.003	0.0029	0.0016	0.0032
1	0.1051	0.1122	0.0316	0.0659	0.0741	0.0367	0.0223
2	0.2539	0.2379	0.2555	0.2237	0.1629	0.1746	0.1609
3	0.1647	0.2382	0.3362	0.2817	0.2076	0.1754	0.236
4	0.1505	0.1851	0.3966	0.3358	0.3338	0.2087	0.2996
5	0.1501	0.1663	0.3301	0.3857	0.4329	0.3032	0.2064
6	0.251	0.1743	0.1246	0.2438	0.4545	0.3478	0.3277
7	0.1762	0.1734	0.2062	0.2022	0.2415	0.2493	0.2494
8	0.2566	0.3144	0.319	0.1867	0.1912	0.1955	0.3291
9	0.2692	0.3975	0.379	0.3347	0.1696	0.1736	0.2396
10	0.2266	0.2345	0.1827	0.2267	0.2155	0.1337	0.2422
11+	0.2266	0.2345	0.1827	0.2267	0.2155	0.1337	0.2422

Table F-1. New Revised values 2004 Atlantic king mackerel tuned VPA results for AGE 1-11+ Model selected by the MSAP 2003 (not published before).

Stock at Age at beginning of year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0														
1	1210735	907275	958011	1211402	1619653	2041006	1581347	844165	1130889	2757375	1794279	932087	917008	1210735
2	1887637	1036664	775784	797434	1038803	1313971	1647155	1178055	708609	909387	2248425	1455447	730611	1887637
3	1283265	1611419	886936	611932	677017	777063	925779	1221576	812939	515861	632229	1638099	1012871	1283265
4	1375652	1052685	1367822	670371	508488	559028	561821	667448	873337	572165	371322	448246	1151120	1375652
5	1060068	1041420	839351	1112329	482467	377677	350579	395665	469782	660186	408054	254565	320246	1060068
6	805437	791055	739105	594431	832332	323947	266173	233602	285025	340355	492792	259062	178704	805437
7	813293	599266	525340	568761	401542	593096	220684	191359	144761	203497	237399	346882	174546	813293
8	304068	575461	365245	333228	356633	190836	424641	158692	106997	95309	150614	161894	255763	304068
9	87740	213167	352584	188071	236857	122459	111750	344177	115853	76612	67611	101127	121805	87740
10	277220	9266	158328	239761	99967	149094	88871	83313	252761	90632	40896	47114	70069	277220
11+	358343	502256	328266	330202	363680	319841	325824	305554	243271	350822	314790	241167	179267	358343

	95	96	97	98	99	100	101	102
0								
1	1066527	1253113	2074110	2799000	832306	2986249	1050723	319182
2	744112	834239	974172	1736524	2322631	662195	2495032	888055
3	550052	510401	580283	667887	1233192	1834637	472869	1889746
4	752289	414043	357201	373348	450978	893129	1450330	314929
5	888546	577817	308132	221405	243866	295149	650458	1098510
6	245669	682434	440773	207771	141863	151147	201192	478052
7	122055	172220	517376	347840	151481	89546	102674	137273
8	118788	90826	129388	386340	261940	112084	66334	75849
9	181007	82944	61025	87962	294778	200421	86237	47933
10	87665	125937	52759	39914	60457	229038	156205	65526
11+	155649	175227	217624	204621	181222	182431	328304	367625

F at Age during year

	81	82	83	84	85	86	87	88	89	90	91	92	93	94
0														
1	0.0052	0.0066	0.0335	0.0037	0.0592	0.0644	0.1444	0.025	0.068	0.054	0.0593	0.0935	0.0589	0.0052
2	0.0082	0.006	0.0873	0.0137	0.1403	0.2002	0.1489	0.221	0.1675	0.2135	0.1667	0.2125	0.1339	0.0082
3	0.0481	0.0139	0.1299	0.0352	0.0415	0.1743	0.1772	0.1856	0.2012	0.1788	0.1939	0.2028	0.1474	0.0481
4	0.1283	0.0765	0.0568	0.1789	0.1474	0.3166	0.2006	0.2012	0.1298	0.188	0.2275	0.1863	0.1089	0.1283
5	0.1427	0.1929	0.195	0.14	0.2483	0.1999	0.256	0.178	0.1723	0.1424	0.3043	0.2038	0.1151	0.1427
6	0.1457	0.2593	0.112	0.2423	0.1889	0.2338	0.18	0.3285	0.1869	0.2102	0.2011	0.2449	0.2313	0.1457
7	0.1959	0.3451	0.3052	0.3168	0.5939	0.1841	0.1798	0.4314	0.268	0.1509	0.2328	0.1547	0.2349	0.1959
8	0.2052	0.3399	0.5138	0.1914	0.9189	0.3851	0.0601	0.1646	0.184	0.1933	0.2483	0.1345	0.1957	0.2052
9	2.098	0.1474	0.2356	0.482	0.3129	0.1706	0.1437	0.1587	0.0955	0.4777	0.2112	0.2169	0.1789	2.098
10	0.0854	0.2936	0.2377	0.2993	0.2213	0.2141	0.1554	0.3191	0.1964	0.1882	0.2386	0.3251	0.3212	0.0854
11+	0.0854	0.2936	0.2377	0.2993	0.2213	0.2141	0.1554	0.3191	0.1964	0.1882	0.2386	0.3251	0.3212	0.0854

	95	96	97	98	99	100	101
0							
1	0.0956	0.1018	0.0276	0.0366	0.0786	0.0297	0.0182
2	0.227	0.213	0.2275	0.1923	0.0859	0.1867	0.1279
3	0.134	0.2069	0.291	0.2427	0.1726	0.0851	0.2565
4	0.1139	0.1454	0.3283	0.2759	0.2739	0.1671	0.1278
5	0.1139	0.1207	0.2441	0.2951	0.3284	0.2332	0.158
6	0.2052	0.1269	0.0868	0.166	0.3101	0.2367	0.2323
7	0.1455	0.136	0.1421	0.1336	0.1512	0.1501	0.1528
8	0.2092	0.2477	0.2359	0.1205	0.1177	0.1122	0.1749
9	0.2128	0.3024	0.2746	0.225	0.1023	0.0992	0.1246
10	0.1783	0.1749	0.1287	0.1496	0.1312	0.0758	0.1261
11+	0.1783	0.1749	0.1287	0.1496	0.1312	0.0758	0.1261

Table 16. (Old values as presented at the MSAP 2003) Maximum sustainable yield (MSY) and optimum yield (OY) related values from the Base model and the Full index model for Atlantic king mackerel 2003 stock evaluation. SS is spawning stock biomass in trillions of yolked eggs, F values are associated with the fully selected age, and yields are given in millions of pounds. 80% confidence intervals generated from 500 bootstrap projections.

MODEL BASE

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	2.681	0.298	5.216	4.190	0.213	5.534
low 80%	0.741	0.257	1.364	3.170	0.182	4.115
upp 80%	4.793	0.359	9.060	9.890	0.256	11.653
Deterministic	2.669	0.271	5.169	3.559	0.193	4.776

MODEL Full Index

	SS MSY	F MSY	MSY	SS OY	F OY	OY
Median	2.573	0.300	5.021	3.901	0.211	5.304
low 80%	0.869	0.262	1.545	3.034	0.186	4.030
upp 80%	3.649	0.353	7.338	6.586	0.254	8.121
Deterministic	2.507	0.269	4.953	3.342	0.189	4.598

Table 17. (Old values as presented at the MSAP 2003) Estimated acceptable biological catch (ABC) in millions of pounds for the Atlantic king mackerel 2003/04 fishing year under a projected F of $F_{30\%SPR}$ or $F_{40\%SPR}$ from the Base and Full index models evaluated. Probability denotes the likelihood of exceeding the desired F mortality rates.

Probability	Base Model		Full Index Model	
	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$
50% Median	6.378	4.673	5.750	4.164
10% lower CI	3.872	2.816	3.522	2.581
90% upper CI	16.161	12.151	11.805	8.764

Table 16-A. (Updated values 2004) Maximum sustainable yield (MSY) and optimum yield (OY) related values from the Base model and the Full index model for Atlantic king mackerel 2003 stock evaluation. SS is spawning stock biomass in trillions of yolked eggs, F values are associated with the fully selected age, and yields are given in millions of pounds. 80% confidence intervals generated from 500 bootstrap projections.

Model	Base	SS MSY	F MSY	MSY	SS OY	F OY	OY
	Median	2.937	0.294	5.771	4.122	0.207	5.566
	low 80%	1.713	0.253	3.125	3.271	0.178	4.376
	upp 80%	4.035	0.344	8.033	5.435	0.243	7.548
	deterministic	2.744	0.272	5.398	3.659	0.191	5.004

Model	Full Index	SS MSY	F MSY	MSY	SS OY	F OY	OY
	Median	2.584	0.296	5.084	3.704	0.207	5.081
	low 80%	1.344	0.262	2.567	3.005	0.183	4.019
	upp 80%	3.449	0.343	6.983	4.700	0.237	6.544
	deterministic	2.511	0.269	4.957	3.347	0.189	4.601

Table 17-A. (Updated values 2004) Estimated acceptable biological catch (ABC) in millions of pounds for the Atlantic king mackerel 2003/04 fishing year under a projected F of $F_{30\%SPR}$ or $F_{40\%SPR}$ from the Base and Full index models evaluated. Probability denotes the likelihood of exceeding the desired F mortality rates.

Probability	Base Model		Full Index Model	
	$F_{30\%SPR}$	$F_{40\%SPR}$	$F_{30\%SPR}$	$F_{40\%SPR}$
50% Median	6.513	4.778	5.169	3.746
10% lower CI	4.230	3.086	3.262	2.387
90% upper CI	10.693	7.696	7.956	5.728

Table F-2. (**Updated values 2004**) Atlantic king Base 1-11+ (run chosen by the MSAP for Atlantic king 2003)

	F MSY	MSY	SS MSY	F OY	OY	SS OY
Median	0.290	5.666	2.923	0.206	5.768	4.395
low 80%	0.256	2.623	1.429	0.181	4.515	3.424
upp 80%	0.346	8.318	4.194	0.244	7.883	5.832
Deterministic	0.262	5.888	3.054	0.187	5.424	4.072

Table F-3. (**Updated values 2004**) Atlantic king Base 1-11+ (run chosen by the MSAP for Atlantic king 2003)

Probability	Base Age1-11+	
	F_{30%SPR}	F_{40%SPR}
50% Median	7.984	5.805
10% lower CI	6.084	4.481
90% upper CI	10.661	7.775

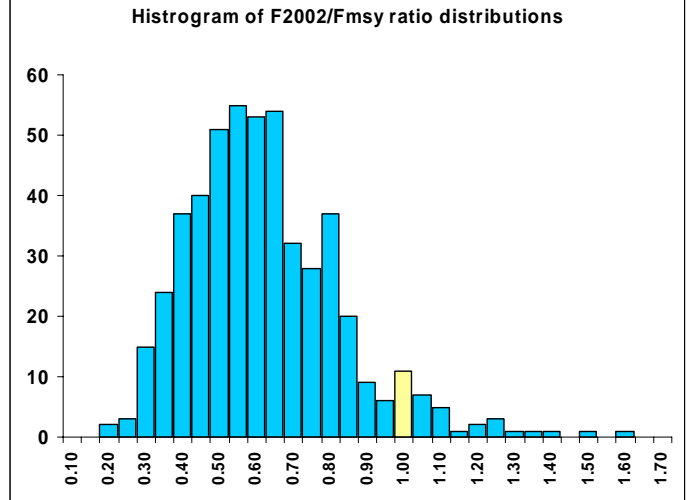
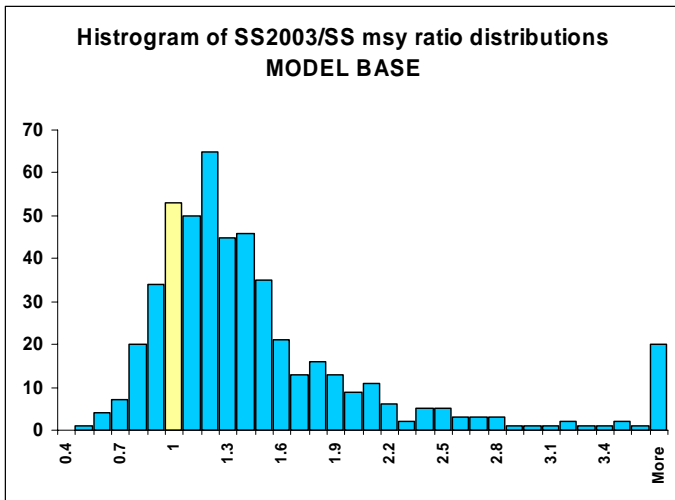


Figure 26 (Updated values MSAP/03/01). Frequency distribution of Atlantic king F_{2002}/F_{MSY} and SS_{2002}/SS_{MSY} ratios of 500 bootstraps for the Base model.

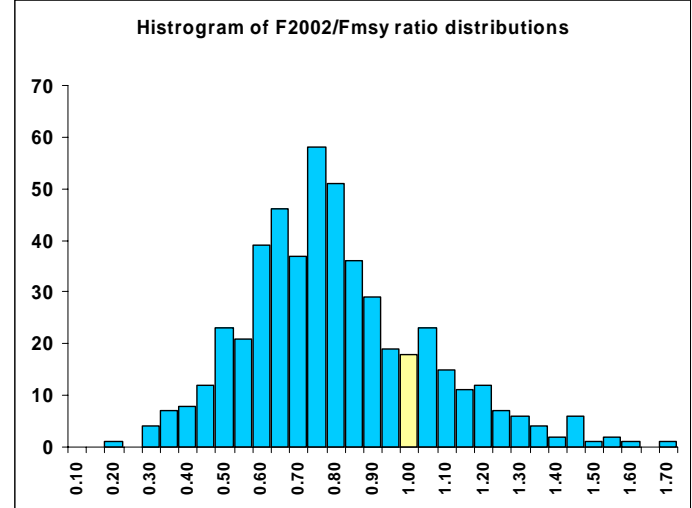
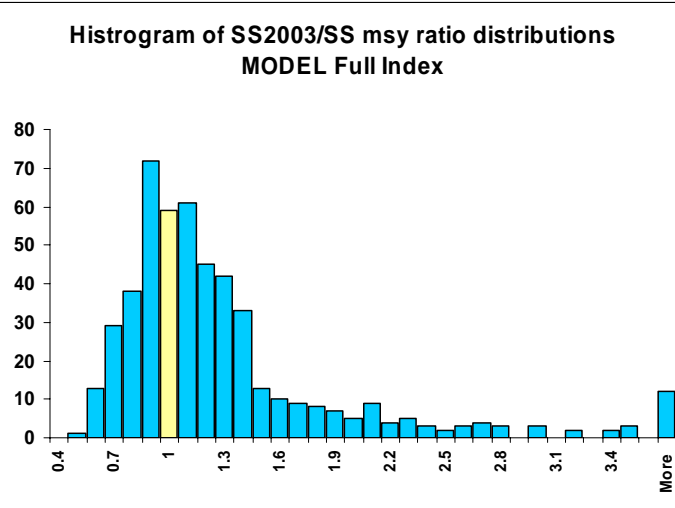


Figure 27 (Updated values MSAP/03/01). Frequency distribution of Atlantic king F_{2002}/F_{MSY} and SS_{2002}/SS_{MSY} ratios of 500 bootstraps for the Full Index model.

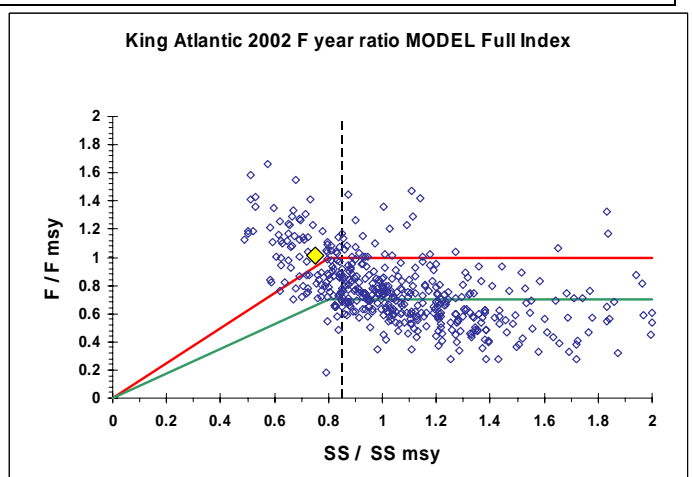
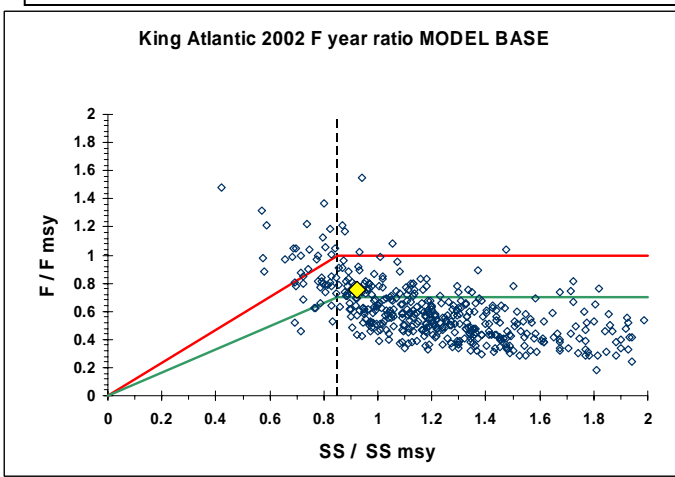


Figure 28 (Updated values MSAP/03/01). Phase plots of 500 bootstraps for the Base and Full index models. The upper solid line denotes the MFMT, the vertical dashed line denotes MSST, and the lower solid line denotes the OY control rule. The deterministic run corresponds to the larger diamond marker.

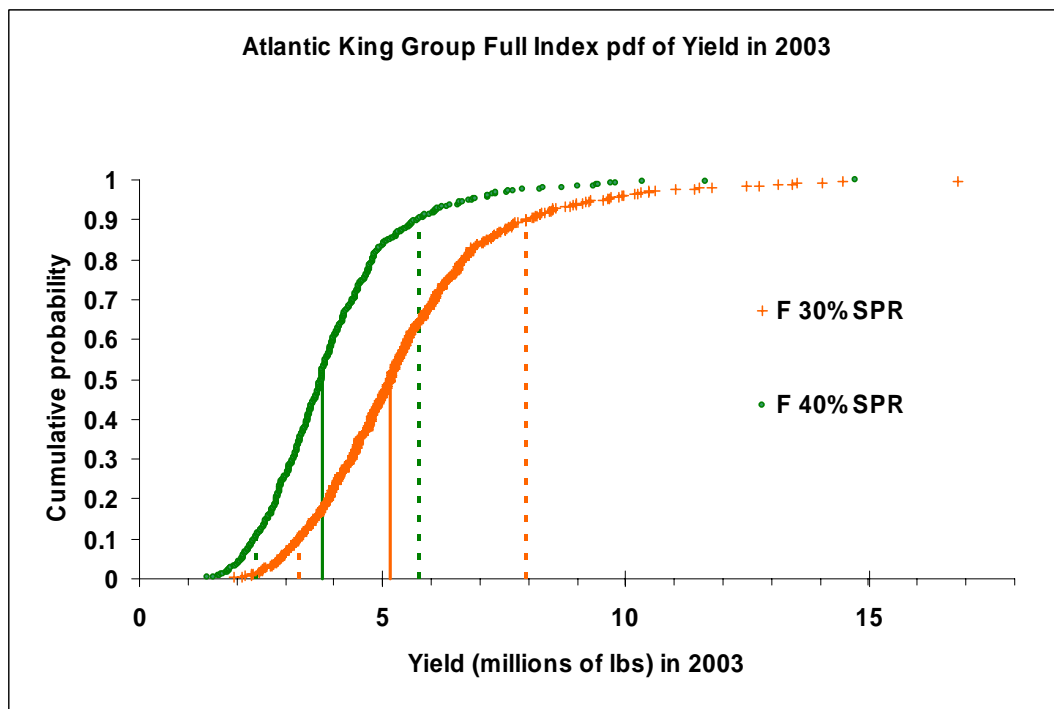
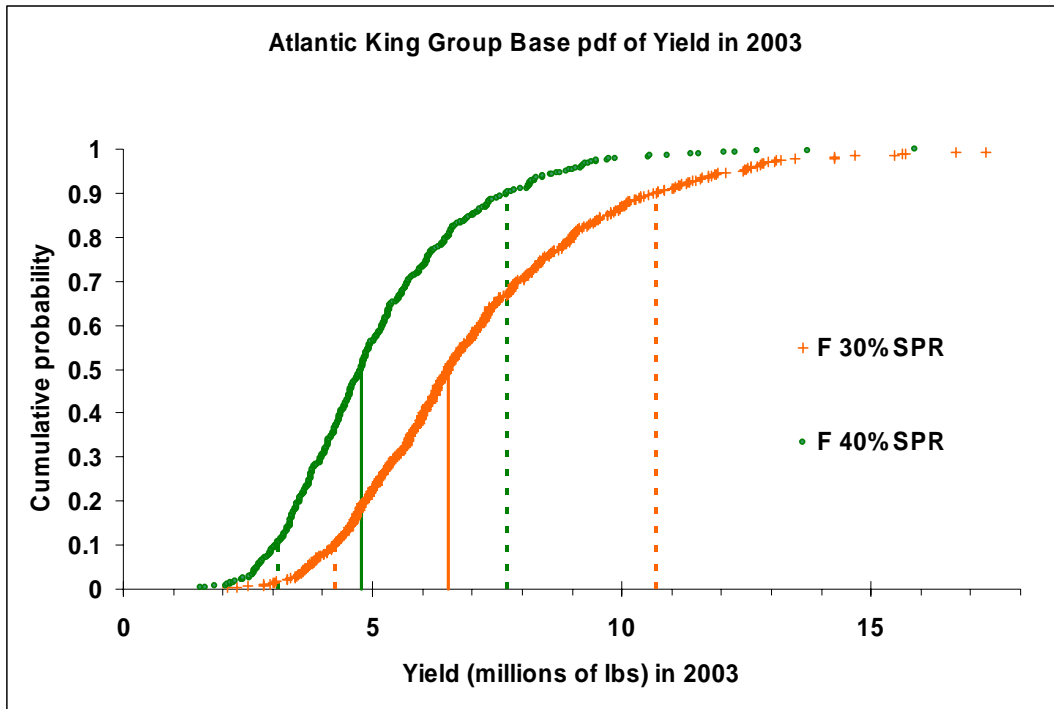


Figure 29. Frequency distribution of 500 bootstraps range of ABC based on probability of F exceeding F30%SPR and F40%SPR in the 2003/04 fishing year for Atlantic king mackerel under the two models. Vertical solid lines represent 0.5 percentile, dashed lines represent 0.1 and 0.9 percentiles of the cumulative distributions.

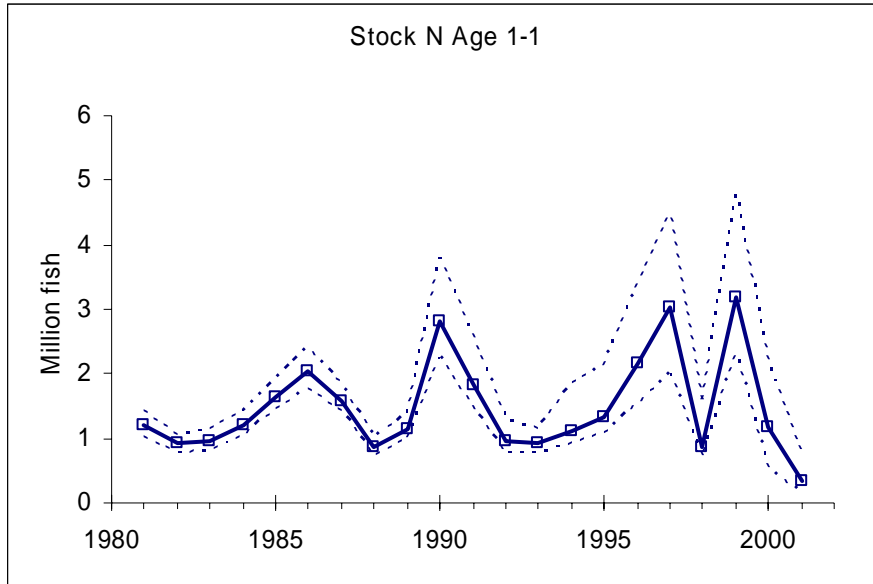


Figure 2 (MSAP 2003 Report Updated figure). Estimated abundance of Age-1 Atlantic group king mackerel recruits from the 2003 base model with the stock-recruit relationship estimated with age-1 recruits. Eighty percent confidence intervals also are plotted. .

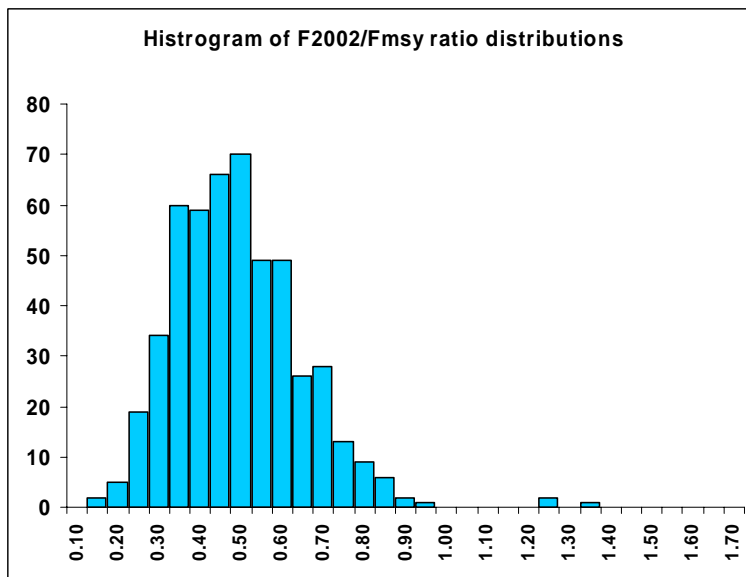


Figure 3..(MSAP 2003 Report Updated figure).Estimated Atlantic group king mackerel $F_{2002/03}/F_{MSY}$ from the 2003 base model with the stock recruit relationship estimated with age-1 recruits.

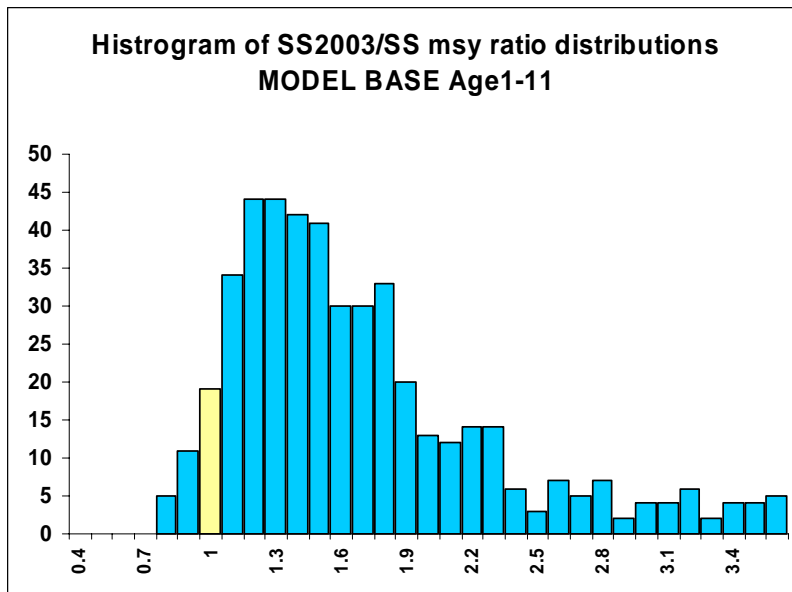


Figure 4, (MSAP 2003 Report Updated figure). Estimated Atlantic group king mackerel B_{2003}/B_{MSY} from the 2003 base model with the stock-recruit relationship estimated with age-1 recruits.

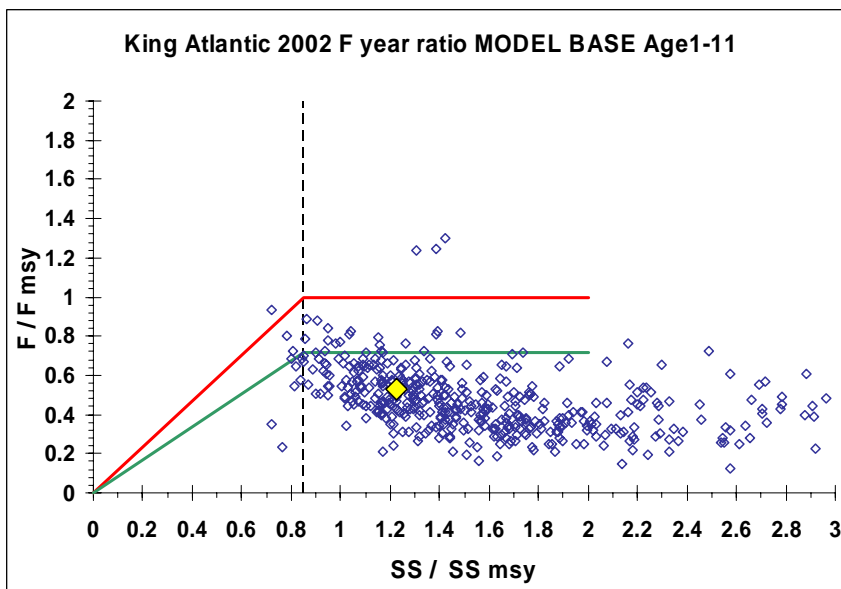


Figure 5. (MSAP 2003 Report Updated figure). Atlantic group king mackerel phase plot from the 2003 base model with the stock recruit relationship estimated with age-1 recruits.

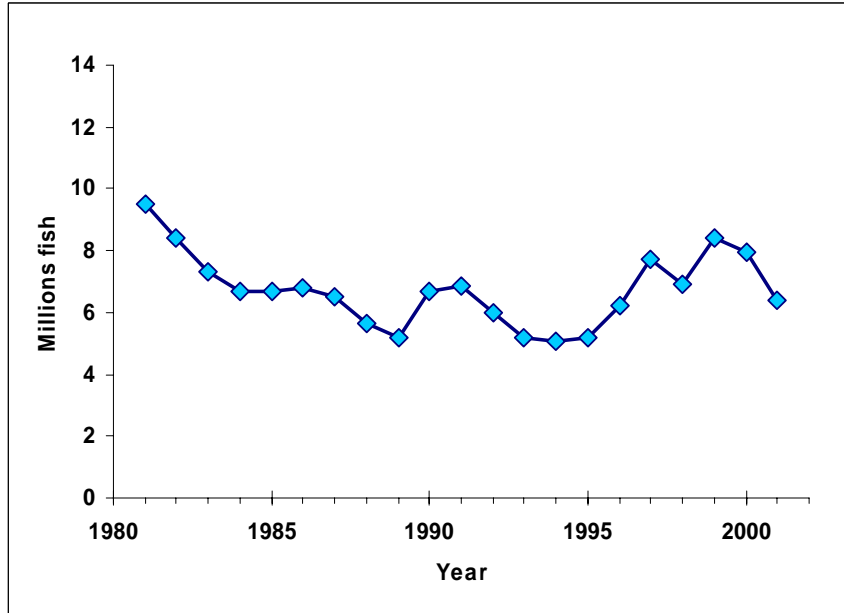


Figure 6. (MSAP 2003 Report Updated figure). Estimated Atlantic group king mackerel stock abundance from the 2003 base model with the stock-recruit relationship estimated with age-1 recruits (sum of ages 1-11+)

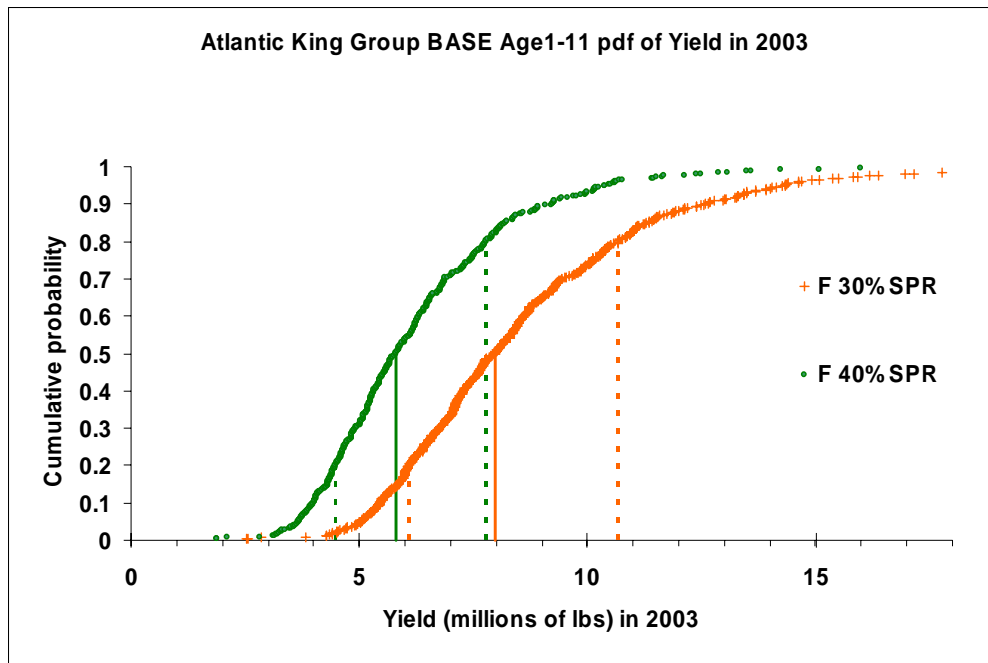


Figure 9 (MSAP 2003 Report Updated figure) Probability density functions of Atlantic group king mackerel allowable biological catch estimated with the 2003 base model, with the stock-recruit relationship estimated with age-1 recruits, for $F_{30\%SPR}$ and $F_{40\%SPR}$ fishing mortalities in the 2003/04 fishing year. Cumulative probabilities are the probability a given yield will exceed $F_{30\%SPR}$ or $F_{40\%SPR}$.