Further Projections for Gulf and Atlantic King and Spanish Mackerel Migratory Groups

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Introduction

Projections of the last full assessment results, conditioned on recent catch levels, for the four mackerel migratory groups were continued under a range of possible future catches to examine the potential for overfishing and the stock becoming overfished. The last full assessment was conducted in 1998 using data through the 1996/97 fishing year for three of the four migratory groups of mackerels: Atlantic king, Atlantic Spanish, and Gulf Spanish. Gulf king mackerel were reassessed in 2000 using data through the 1998/99 fishing year. The projections make use of recent catch level information and follow the methodology used in the 1999 update for the mackerel assessments and just continue the projections further into the future. The methods and proxies for defining overfishing and overfished levels based on maximum sustainable yield (MSY) and optimum yield (OY) fishing mortality rates and spawning stocks that were agreed upon at the 1999 mackerel stock assessment panel meeting were followed. The current total allowable catch (TAC), median MSY and median OY catches were projected into the future to examine the risks of overfishing or the stock becoming overfished, should catches equivalent to these levels be realized into the future. An examination of how quickly the stock can be reduced under low levels of recruitment was also conducted. The potential for monitoring, without full assessments, the stocks currently classified as neither overfished nor undergoing overfishing is also examined.

Methods

The stock assessment methods are described in Legault *et al.* (1998 and 2000) and the projection methods described in Legault (1999), and in Legault *et al.* (2000). Briefly, the stock assessment is based on tuned virtual population analysis (VPA). A mixed bootstrap/Monte Carlo simulation is used to incorporate uncertainty into the estimates of stock abundance and fishing mortality rates. The residuals over all tuning indices are bootstrapped and the natural mortality rate and catch (and bycatch) levels are chosen randomly through Monte Carlo simulation. Each bootstrap/Monte Carlo simulation is projected into the future based on total catches in the two sectors, commercial and recreational, which are not separated by age, and a bycatch fishing mortality rate from the shrimp trawl fleet (Gulf only). These projections assume bootstrap specific selectivity patterns for the commercial and recreational fisheries, which are computed, based on partial catches by each gear and the estimated fishing mortality rates at age in the last five years of the VPA. The two fishing mortality rate multipliers, one commercial and one recreational, are calculated which match the desired catch in weight or number by each gear.

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Future recruitment is drawn randomly from a lognormal distribution with mean and variance computed from recruitment estimates in specific years in each particular bootstrap: Atlantic king 89-96, Gulf king 87-96, Atlantic Spanish 89-96, and Gulf Spanish 85-96. These years for defining the recruitment distribution were based on having tuning index information for either the spawning stock or recruitment values (MSAP 1999, MSAP 2000). An empirical stock recruitment relationship was formulated for each stock, which had recruitment decreasing linearly to the origin when stock size was below the average of the five smallest stock sizes within the years given above. The low recruitment scenario was formed for each bootstrap by setting the mean of the lognormal distribution to the average of the five lowest recruitment estimates over all years in that bootstrap. The same variance as the average recruitment scenario was used for the lognormal distribution. This model of stock recruitment relationship was continued with the break point calculated as in the average recruitment scenarios. The low recruitment values started in the year 2000 and used the same series of random deviates as the average recruitment scenario to facilitate comparison between the two scenarios.

Maximum sustainable yield (MSY) for each bootstrap was determined based on the yield per recruit (YPR) under a given fishing mortality rate proxy for F_{MSY} and the average recruitment described above for that bootstrap. The F_{MSY} proxy was F30%SPR, the fishing mortality rate that generates 30% of the virgin spawning potential in equilibrium. The spawning stock at MSY (SS_{MSY}) was calculated in a similar manner using the spawning stock per recruit at F_{MSY} proxy multiplied by the average recruitment for each bootstrap. The estimated fishing mortality rate and spawning stock size in each projection year were compared to the corresponding MSY proxies. The probabilities of overfishing and being overfished were calculated as the fraction of bootstraps that resulted in that year's F being above the maximum fishing mortality threshold (MFMT) and that year's spawning stock being below the minimum stock size threshold (MSST), respectively. The MFMT was calculated for each bootstrap as the Fmsy proxy (F30%SPR) for spawning stock sizes above the MSST with a linear decline to the origin for stock sizes below the MSST. The MSST was calculated for each bootstrap as the product of (1-M) and SSmsy. Both the MFMT and MSST are calculated according to the default control rule of Restrepo *et al.* (1998) and were used in the last two MSAP meetings (MSAP 1999, MSAP 2000). The optimum yield (OY) control rule was calculated in similar manner replacing F30%SPR with F40%SPR in the calculations based on the last two MSAP meetings as well (MSAP 1999, MSAP 2000).

Results and Discussion

Recent and Near-Future Catches:

For this analysis, catches through fishing year 1999 were based on available records from the normal sources were applied. Tables 1-4 present the estimates of landed catch used for each of the 4 migratory groups of mackerels. Likewise, Figures 1-4 show the time-series of catch in units of million pounds, over the time period by the commercial and recreational fishing sectors. Except where noted below, FY2000 landings were set equal to the most recent TAC for each migratory group.

For the Gulf group of King mackerel, the estimated FY99 commercial landings were based on the Accumulated Landings System (ALS) database (as available on 23 February 2001) and on the current quota monitoring (QM) files. For the western zone Hook&Line (H&L) fishery, landings in FY99 were taken as 1,143,114 Lbs based on both the ALS and QM data. The landings data from TX, MS and AL are from the ALS; LA landings are from QM (from Josh Bennett/Mark Godcharles based on data from Keith Roberts), as the figures sent to us from LA and those on the ALS for LA are clearly incomplete. For the FL east coast H&L fishery, 683,133 Lbs was used. This volume is based on current figures from the Florida Fish and Wildlife Conservation Commission (FFWCC) and is lower than the lower end of the range of projection for FY99 made last year (877,000-1,053,000, see Legault *et al*. 2000). The optimistic projection about the weather and general fishing success during March-April, 2000, did not play out and the catch from this fishery was well below the allocation. For the FL west coast H&L fishery, a value of 578,694 Lbs from FFWCC was used. While a value of 466,630 Lbs from QM files was used for the FL west coast gillnet fishery. The total estimated FY99 commercial landings for Gulf group king mackerel were thus 2,871,571 Lbs, about 85% of the commercial allocation for FY99.

For the estimated FY99 recreational catch of Gulf group king mackerel, complete catch estimates were not available from either the Headboat survey or from the Texas Parks and Wildlife Department (TPWD). For these data sources, catches from the most recent 12-month period available were substituted for FY99 catches. For the Headboat catch, the most recent data came from Jan-Dec, 1998 (31,213 fish); for TPWD the most recent data came from Jan-Dec 1999 (33,014 fish). The balance of recreational harvest estimates came from MRFSS. For FY99 (July, 1999-June, 2000), the MRFSS estimate used was 397,860 fish (247,255 charter ("old method" - see below) + 30,568 shore + 139,948 priv/rental). The resulting total estimated FY99 recreational landings for Gulf group kings was thus about 4.5 million Lbs (see Table 1).

For Atlantic Group king mackerel and the Gulf and Atlantic Group Spanish mackerels, commercial landings for FY99 were as reported from cooperating states to the ALS. For the recreational sector, the old method (see below) estimates from MRFSS were applied. Headboat catches for calendar year 1998 were also used for FY99 and TXPWD estimates from calendar year 1999 were used in substitution for FY99 (as above).

Projected FY00 Landings

For the purposes of projection of Atlantic king mackerel and both Spanish mackerel migratory groups, FY00 landings were assumed to be equal to the established FY00 TAC for each migratory group. In the case of Gulf group king mackerel, additional information on current year (FY00) commercial landings is available through quota monitoring efforts. For Gulf group king mackerel, the Western zone H&L fishery was closed on August 26, 2000, after quota monitoring data indicated that landings would likely exceed the allowable allocation if the fishery continued beyond that date. The total landings in FY00 from the Western zone H&L fishery from the QM data files are 1,049,472 Lbs. For the FL east coast H&L fishery in FY00, current (incomplete) landings come from the QM data through January 2001. Through January, the fishery had landed 403,761 Lbs. The total volume of landings for the fishing year is not yet known since the fishing season has not ended. Based on FY99 performance and feedback from field agents, it is projected that landings for this fishery could fall within the range of 603,000-903,000 Lbs. The future landings could be low if weather is bad in the balance of the fishing season or if the fish move off. As the recent weather has been favorable, the projection for February is on the order of 200,000 Lbs; the range of projection for March is between 0 and 200,000 Lbs. Overall, in FY00 (as in FY99), the odds for the FL east coast H&L fishery achieving the total allocation appears low. For the FL west, northern H&L fishery, the fishery was closed in November 2000, with landings of 182,956 Lbs from the QM files. For the FL west, southern H&L fishery, the QM files indicate that the fishery will likely land its allocation of 541,125 Lbs. For the FL west, southern gillnet fishery, the QM data indicated landings of 561,559 Lbs occurred. Based on these data and projections, the total projected commercial landed catch for Gulf group king mackerel in FY00 ranges from 2,938,112 - 3,238,112 Lbs. For the purposes of the projections described, a value of 3,088,112 Lbs was used for the commercial component in FY00. For the recreational component of the all of the mackerel migratory group fisheries, the FY00 expected landed catch was set equal to the recreational TAC.

MRFSS New Methodology.

After several years of testing, MRFSS instituted a new method for estimating charterboat catches. This new component of the recreational survey includes compiling and maintaining a directory of recreational fishing charter boats for all coastal states, conducting weekly telephone surveys of a random sample of the charter boat operators in each state, and conducting weekly dock-side sampling to validate the self-reported telephone data. In year 2000, this sampling was implemented in Gulf States, but not in Atlantic coastal states. A comparison of the "New Method" and "Old Method" MRFSS Charterboat estimates for calendar year 2000 are provided below by species and migratory group. In view of, as of yet, a lack of a suitable period of overlap in estimates by new and old methods, to provide a basis for correcting historic estimates, the "Old Method" estimates of charterboat catch are used in the current analyses.

Charterboat mode (numbers A+B1) for King Mackerel:

With *new method* MRFSS estimates for charterboats in 2000 (note: an error in SC, wave 5, on the web site has been corrected in Table 5 (see shaded cells); the correct number is the same as in the "Old method" table entry), the stratum-wise estimated catch from the Gulf migratory group of king mackerel is

generally lower than estimates made with the old method. The predominate strata contributing to the difference are those for the Florida west coast (FLW, Table 5). This result is not surprising since FLW has the largest catches of this species and since the new method was not implemented for Atlantic coastal states in year 2000. The estimated charterboat catch of Gulf migratory group king mackerel in January through June (fishing year 99) was 78,201 fish (A+B1), compared to an estimate for the same time period of 88,482 fish based on the old methodology. While for the calendar year, the new method estimate of Gulf migratory group king mackerel is 149,748 fish while the old method estimate is 225,730 fish. Because the new method was not implemented for Atlantic coastal states in year 2000, no further comparison can be drawn.

Charterboat mode (numbers A+B1) for Spanish Mackerel:

With *new method* MRFSS estimates for charterboats in 2000, the estimated catch from the Gulf migratory group of Spanish mackerel is *generally higher* than estimates made with the old method. The predominate strata contributing to the difference are those for the Florida west coast (FLW, Table 6). The new method estimated charterboat catch of Gulf migratory group Spanish mackerel in January through June (fishing year 99) was 96,289, nearly identical to the old method estimate of 96,322 fish (A+B1). While for the calendar year, the new method estimate of Gulf migratory group Spanish mackerel is 197,857 fish while the old method estimate is 160,636 fish. Because the new method was not implemented for Atlantic coastal states in year 2000, no further comparison can be drawn.

Shrimp Bycatch estimates

For the Gulf groups of Spanish and king mackerel, updated estimates of shrimp bycatch in FY2000 were not available. For Gulf king projections assume the bycatch mortality reduction used in the 2000 assessment (MSAP 2000) of 50% from 1999 on. For Spanish mackerel, latest bycatch estimates (GLM method) were for 1999 (Table 7, GLM 2000). A comparison of bycatch estimates used in the 1998 assessment and those of 1999 are very similar. Bycatch reduction in 1997, 1998 and 1999 were compare to the average of 1994-96 years. By 1999 a 35% reduction was observed, which was used for the years 2000 and beyond.

Short-term Projections:

Short-term projections were carried out, conditioned on recent estimated catch levels, to project expected catch levels in FY2001 under $F_{30\%SPR}$ (F_{MSY}) and $F_{40\%SPR}$ (F_{OY}) fishing rate levels. Figures 5-8 show the projected stock and fishing rate status relative to MSY reference points (SS/SS_{MSY}, F/F_{MSY}) for taking into account observed and projected catch through FY00, for each of the mackerel migratory groups. Also indicated in these Figures are the projected catch levels in FY01 under $F_{30\%SPR}$ and $F_{40\%SPR}$ fishing rates. Figures 9-12 show time-trajectories of estimated and projected fishing mortality rates, stock biomass, and measures of SPR for each mackerel migratory group through FY00, conditioned on recent estimated and projected catch levels.

Long-term Projections:

According to the control rules discussed at the most recent MSAP meetings (MSAP 1999, MSAP 2000), the Atlantic king and Spanish and the Gulf Spanish mackerel migratory groups would all be classified as not overfished and not undergoing overfishing (see, for example Figure 7 in MSAP 1999).

The recent total allowable catch (TAC) along with the median and 80% confidence intervals for the control rule parameters for each migratory group are given in Table 8. The recent TAC was set greater than both MSY and OY for the Spanish mackerels. As both migratory groups have estimated spawning stock sizes well above SS_{MSY}, this means that fishing mortality rates corresponding to MSY or OY can produce larger catches than the MSY and OY values, but will cause the spawning stock size to decline towards SS_{MSY} and SS_{oy}. Thus, these catches are not sustainable indefinitely and will have to be reduced later if future recruitment follows the expectation used in the calculations of MSY and OY. It is notable that catches at the level of recent TAC have not been realized by the Gulf Spanish mackerel fisheries since FY86 and the has not been realized by the Atlantic Spanish mackerel fisheries since FY84 or earlier.

Projection of the three catches (TAC, MSY and OY) well into the future for the 400 bootstraps of each mackerel migratory group resulted in probabilities of exceeding targets and thresholds as summarized in

Table 9 and Figure 13. In all cases, higher catches produced higher probabilities of exceeding the targets and thresholds (larger F and smaller spawning stock) as expected. Atlantic king and Spanish and Gulf Spanish mackerel all increase or remain level in the probabilities further into the future as the spawning stock size decreases under all three levels of catch. The probabilities associated with overfishing, P(F>F_{MSY}), and being overfished, P(SS<MSST), can be compared directly to the probability of achieving the target levels associated with optimum yield. The best case scenario would have a low probability of exceeding the overfishing and overfished thresholds and no more than a 50% probability of exceeding the target values. All three of the projected catches for Atlantic king mackerel meet these criteria, as do the OY projections for the two Spanish mackerel groups. However, the other projections for the Spanish mackerel groups results in higher, and increasing, probabilities of overfishing and being overfished in the future with lower probability of achieving the target.

The projection results can also be visualized as phase plots (see Figure 7 of MSAP 1999 and Figure 11 of MSAP 2000) each year. The spread of the points in the year 2010 forms the usual "banana" associated with constant catch projections. This shape is caused by positive feedback. A catch that is too high for a particular bootstrap causes a larger than desired F which decreases the stock size. The next year the same catch then creates a larger F and decreases the stock size further. Similarly, a catch that is too small for a particular bootstrap causes a lower than desired F which increases the stock size. The next year the same catch then creates a smaller F and increases the stock size further. The points in the phase plot thus spread towards the upper left and lower right. The movement towards the upper left, low spawning stock size and high F, is exacerbated by the stock recruitment relationship in this case. Once the spawning stock decreases below the break point in the two line model recruitment drops linearly with stock size. Thus, the bootstraps that get into a low stock size have a low chance of coming back out due to recruitment variability and a high probability of crashing (no longer able to produce the level of catch). This creates a problem for displaying the results because many of the points end up along the y-axis. To allow comparison of the spread of results in 2010, polygons were drawn around the 10^{th}, 25^{th}, and 50^{th} percentile of the bootstraps closest to the median results (Figure 14). As expected, lower catches move the polygons to the right and down on the phase plots. In all cases there are bootstraps above and below both the overfishing and overfished thresholds and thus the status of the stock could not be classified.

All of the above results depend upon future recruitment following a lognormal distribution with mean and variance from the estimated recruitments for each bootstrap that had tuning index information. In general, these recruitment values contain the highest estimates while excluding some of the lower estimates. This means that recruitment in the future would on average be better than has been estimated over the time frame available. In order to examine the sensitivity of the projections to this choice for future recruitment, a second set of projections was made using a lognormal distribution with mean equal to the average of the five lowest recruitment estimates for each bootstrap considering all years in the VPA. Note that this is not necessarily a recruitment failure scenario, but rather a level of recruitment that corresponds to values that have been estimated within the past two decades. As expected, the low recruitment scenario causes the probabilities of exceeding the targets and thresholds to be greater than the average recruitment scenario (Table 10 and Figure 13). Lower future recruitment would cause even higher probabilities while higher future recruitment would cause lower probabilities.

One way to detect low recruitment when full assessments are not conducted is through the currently used tuning indices for the migratory groups. While most of the tuning indices are for adult fish and cover many age groups, thus limiting their utility as a means to detect recruitment changes, each of the four mackerel migratory groups does have one tuning index for juvenile fish (Table 11 and Figure 15). These indices are based on scientific groundfish surveys and shrimp trawl bycatch measures and thus are independent of the directed fishery. These indices are true recruitment indices for the king mackerel groups, but contain multiple ages for the Spanish mackerel groups and thus will be a moving average of recruitment. The Gulf indices are complicated by the implementation of bycatch reduction devices (BRD). For now the GLMs are run without the BRD data and the expected number of fish that would have been caught had BRDs not been used is calculated. This hypothetical catch is then divided by the total effort to allow the values to be compared with previous index values. Note that this procedure only address the difference in CPUE caused by BRD implementation and does not address any changes in fishing effort distribution. The 1999

Gulf bycatch estimates are more variable than previous years due to a lack of observer data (S. Nichols, pers. comm.).

Updates of indices of abundance used in the last assessments for all four migratory groups were also examined when available. The FDEP Florida trip ticket program provided updated indices for both king and Spanish mackerel migratory groups (Tables 12 and 13, courtesy of Dr. R. Muller of the Florida Fish and Wildlife Conservation Commission). For Atlantic and Gulf king, no differences in trends were observed between the 1998 and 2000 standardized-scaled CPUE series. Although the absolute value for the South Atlantic king mackerel was much lower compared to 1998 values (Figure 16). For Gulf Spanish mackerel the trend was also similar between 1998 and 2000 standardized CPUE series (Figure 17). For the Atlantic Spanish, the trends varied considerably depending on whether or not the analysis was restricted to trips with a minimum of 500 lbs per trip. In the 1998 assessment (and in prior assessments) this restriction was not used for Atlantic Spanish mackerel.

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Table 1. Gulf group king mackerel harvest levels by fishing sector.

	Commercial		Recreational		Total	
Fishing Year	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs
81/82	654.3	5.6	298.5	2.9	952.8	8.5
82/83	448.8	4.6	822.6	7.7	1271.4	12.3
83/84	389.0	3.0	341.8	2.4	730.8	5.4
84/85	326.2	3.2	397.8	3.1	724.1	6.3
85/86	377.4	3.6	183.6	1.8	561.1	5.4
86/87	172.4	1.5	442.2	3.3	614.6	4.7
87/88	118.7	0.9	302.8	2.1	421.5	3.0
88/89	121.8	1.4	525.5	5.3	647.3	6.7
89/90	183.7	2.0	514.0	3.4	697.8	5.3
90/91	217.0	1.8	501.8	4.0	718.8	5.8
91/92	223.0	2.1	738.0	4.8	961.0	6.9
92/93	410.3	3.6	631.9	6.3	1042.2	9.9
93/94	266.9	2.6	685.2	6.1	952.1	8.7
94/95	330.2	2.9	792.0	7.9	1122.2	10.8
95/96	290.4	2.6	634.4	6.3	924.8	8.9
96/97	369.4	2.9	662.8	6.9	1032.2	9.8
97/98	401.3	3.5	713.8	6.7	1115.1	10.2
98/99	393.4	3.9	568.6	5.4	744.4	9.3
99/00	296.9	2.9	462.1	4.5	759.0	7.4
2000/01		*3.1*		*7.2*		*10.3*

Notes: Estimated numbers of commercially landed fish and estimated weight of recreationally landed fish in 99/00 fishing year are based on calendar year 1998 average weights of king mackerel landed by each sector (9.7 lbs/fish, and 9.7lbs/fish in the 1998 commercial and recreational sectors, respectively). Estimates for year 2000/01 are based on the Quota Monitoring system for the commercial sector, and the TAC allocation for the recreational sector, respectively.

Table 2. Atlantic group king mackerel harvest levels by fishing sector.

	Commercial		Recreational		Total	
Fishing Year	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs
81/82	275.5	2.4	496.6	4.4	772.2	6.8
82/83	381.8	3.9	529.6	5.2	911.4	9.2
83/84	234.9	2.4	671.1	6.3	905.9	8.7
84/85	181.6	1.9	612.6	6.1	794.2	8.1
85/86	232.9	2.5	818.3	7.1	1051.2	9.6
86/87	277.2	2.8	700.0	6.0	977.2	8.8
87/88	348.1	3.5	543.6	3.9	891.8	7.4
88/89	340.1	3.1	556.4	4.9	896.5	8.0
89/90	283.4	2.6	380.2	3.4	663.6	6.0
90/91	310.0	2.7	439.5	3.7	749.5	6.4
91/92	295.5	2.5	638.5	5.8	934.0	8.3
92/93	269.8	2.2	672.7	6.3	942.5	8.5
93/94	225.1	2.0	375.0	4.4	600.1	6.5
94/95	225.9	2.2	381.7	3.7	607.6	5.9
95/96	180.1	1.9	463.5	4.2	643.6	6.0
96/97	314.8	2.7	382.3	4.0	697.1	6.7
97/98	287.2	2.7	521.3	5.2	808.5	7.8
98/99	285.0	2.5	438.4	4.3	723.5	6.9
99/00	250.1	2.2	355.2	3.5	605.3	5.8
2000/01		*3.7*		*6.3*		*10.0*

Notes: Estimated numbers of commercially landed fish and estimated weight of recreationally landed fish in 99/00 fishing year are based on calendar year 1998 average weights of king mackerel landed by each sector (8.9 lbs/fish, and 10.0 lbs/fish in the 1998 commercial and recreational sectors, respectively). Estimates for year 2000/01 are based on the TAC allocation for the commercial and recreational sector, respectively.

Table 3. Gulf group Spanish mackerel harvest levels by fishing sector.

	Commercial		Recreational		Total	
Fishing Year	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs
84/85	1857.0	3.44	865.3	1.18	2722.2	4.62
85/86	1706.0	3.30	1060.2	1.36	2766.2	4.65
86/87	1250.0	2.05	6334.4	7.52	7584.4	9.57
87/88	1488.2	2.58	1882.1	3.12	3370.3	5.71
88/89	2466.4	3.90	1340.0	2.18	3806.4	6.08
89/90	1100.9	2.15	1249.8	1.86	2350.7	4.00
90/91	1123.9	2.07	1596.0	2.14	2719.9	4.21
91/92	2075.0	4.16	2014.0	2.89	4089.0	7.05
92/93	1804.2	3.11	2008.1	3.13	3812.2	6.24
93/94	1431.8	2.61	1794.9	2.70	3226.6	5.31
94/95	1528.7	2.55	1137.6	1.56	2666.3	4.12
95/96	730.5	1.08	1092.4	1.57	1822.9	2.65
96/97	316.4	0.62	1264.7	2.04	1581.0	2.66
97/98	199.9	0.36	1200.2	2.45	1400.1	2.81
98/99	254.1	1.07	1320.0	2.08	1574.1	3.15
99/00	611.0	1.05	1862.6	3.35	2473.7	4.41
2000/01		*5.2*		*3.9*		*9.1*

Notes: Estimated numbers of commercially landed fish and estimated weight of recreationally landed fish in 99/00 fishing year are based on calendar year 1998 average weights of Spanish mackerel landed by each sector (1.7 lbs/fish, and 1.8 lbs/fish in the 1998 commercial and recreational sectors, respectively). Estimates for year 2000/01 are based on the TAC allocation for the commercial and recreational sector, respectively.

Table 4. Atlantic group Spanish mackerel harvest levels by fishing sector.

	Commercial		Recreational		Total	
Fishing Year	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs	Fish (1000s)	Million Lbs
84/85	2184.0	3.29	942.0	1.31	3126.0	4.60
85/86	2346.2	4.19	495.9	0.75	2842.1	4.94
86/87	1906.7	2.57	797.7	1.20	2704.4	3.76
87/88	2445.7	3.56	1052.7	1.47	3498.4	5.03
88/89	2647.4	3.52	1726.0	2.74	4373.4	6.26
89/90	2234.5	3.96	1103.0	1.57	3337.5	5.53
90/91	2066.8	3.56	1323.5	2.07	3390.3	5.63
91/92	2913.4	4.74	1463.7	2.29	4377.1	7.02
92/93	2274.4	3.72	1210.0	2.00	3484.4	5.71
93/94	2524.9	4.81	920.0	1.49	3444.8	6.31
94/95	3169.1	5.23	1084.5	1.38	4253.6	6.61
95/96	1475.6	2.01	784.6	1.09	2260.3	3.10
96/97	2224.7	3.10	658.9	0.85	2883.6	3.95
97/98	1960.7	3.06	1072.3	1.66	3033.0	4.72
98/99	1801.6	3.27	689.2	0.82	2490.8	4.09
99/00	1567.6	2.34	937.4	1.50	2505.1	3.84
2000/01		*3.52*		*3.52*		*7.04*

Notes: Estimated numbers of commercially landed fish and estimated weight of recreationally landed fish in 99/00 fishing year are based on calendar year 1998 average weights of Spanish mackerel landed by each sector (1.7 lbs/fish, and 1.8 lbs/fish in the 1998 commercial and recreational sectors, respectively). Estimates for year 2000/01 are based on the TAC allocation for the commercial and recreational sector, respectively.

Table 5. Comparison of stratum-specific (wave and state) estimates of charterboat harvest (A+B1) in numbers of king mackerel for calendar year 2000.

New Method		**LA**	**AL/MS**	**FLW**	**FLE**	**SC**	**NC**	**ALL**
Wave	1	14		7407	7045			14466
	2		96	14345	13771	36	5736	33984
	3	92	6477	35839	18742	806	2137	64093
	4	308	6689	28187	24608	3016	3923	66731
	5		1979	14443	18970	10881	10402	56675
	6		82	8665	11194	3055	8605	31601
ALL		414	15323	108886	94330	17794	30803	267550
Old Method								
Wave	1	191		21737	7045			28973
	2		300	14388	13772	36	5736	34232
	3	59	4907	32729	18742	806	2137	59380
	4	233	6230	59452	24608	3016	3923	97462
	5		3094	37048	18970	10881	10402	80395
	6		334	19903	11194	3055	8605	43091
ALL		483	14865	185257	94331	17794	30803	343533
Difference (New minus Old)								
Wave	1	-177		-14330				-14507
	2		-204	-43	-1	0	0	-248
	3	33	1570	3110	0	0	0	4713
	4	75	459	-31265	0	0	0	-30731
	5		-1115	-22605	0	0	0	-23720
	6		-252	-11238	0	0	0	-11490
ALL		-69	458	-76371	-1	0	0	-75983

Notes: Shaded cells represent corrected values. Values reported on MRFSS website for these cells are incorrect.

Table 6. Comparison of stratum-specific (wave and state) estimates of charterboat harvest (A+B1) in numbers of Spanish mackerel for calendar year 2000.

New Method		**LA**	**AL/MS**	**FLW**	**ALL**
Wave	1			2601	2601
	2	365	9144	45388	54897
	3	715	7989	30087	38791
	4	594	19240	30447	50281
	5		5828	34351	40179
	6		311	10797	11108
	ALL	1674	42512	153671	197857
Old Method					
Wave	1			5202	5202
	2	52	19311	59098	78461
	3	324	6580	5755	12659
	4	238	16658	12495	29391
	5		5814	19830	25644
	6		689	8590	9279
	ALL	614	49052	110970	160636
Difference (New minus old)					
Wave	1			-2601	-2601
	2	313	-10167	-13710	-23564
	3	391	1409	24332	26132
	4	356	2582	17952	20890
	5		14	14521	14535
	6		-378	2207	1829
	ALL	1060	-6540	42701	37221

Table 7. Bycatch estimates in numbers of fish for Gulf Spanish and king mackerel from the GLM models. For Spanish mackerel percent of reduction for 1997-1999 years is relative to the average of 1994-1996 (shaded cells). Projections of Gulf Spanish mackerel used these values as percentages of bycatch reduction, for years 2000 and on, a 35% bycatch mortality reduction was assumed. Projections of Gulf king mackerel used the last assessment bycatch mortality reduction of 50% from 1999 on.

	Spanish Mackerel			King Mackerel	
Year	GLM 1998	GLM 2000	% Reduction	GLM 2000	% Reduction
1984	2,776,000	2,699,125		492,586	
1985	2,781,000	2,397,688		465,043	
1986	2,894,000	2,821,901		356,040	
1987	3,367,000	3,278,569		828,924	
1988	3,873,000	3,801,991		620,818	
1989	4,129,000	4,059,828		1,286,707	
1990	3,716,000	3,639,846		852,416	
1991	4,126,000	4,060,492		1,071,217	
1992	5,074,000	5,010,976		569,223	
1993	4,748,000	4,692,172		1,018,411	
1994	3,032,000	3,000,906		927,081	
1995	2,725,000	2,634,068		1,097,839	
1996	2,757,000	2,700,473		597,033	
1997		2,561,428	8%	718,253	
1998		2,288,045	18%	380,998	
1999		1,798,590	35%		50%
2000 …			35%		50%

Table 8. Total allowable catch (TAC) in millions of pounds and the median and 80% confidence intervals for control rule parameter values for the Atlantic and Gulf migratory groups of king and Spanish mackerel based on the 1998 (Atlantic kings and Gulf & Atlantic Spanish) and 2000 (Gulf kings) assessment bootstrap/Monte Carlo VPA results. MSY=maximum sustainable yield in millions of pounds, OY=optimum yield in millions of pounds, MFMT=maximum fishing mortality threshold per year, SS_{MSY}=spawning stock at MSY in trillions of eggs (10^{12}) for king mackerel and millions of pounds mature female biomass for Spanish mackerel, MSST=minimum stock size threshold in the same units as SS_{MSY}. Gulf king and Spanish mackerel assume 50% and 25% reduction in shrimp trawl bycatch rates, respectively.

	Atlantic King			Gulf King			Atlantic Spanish			Gulf Spanish		
	Median	80% CI		Median	80% CI		Median	80% CI		Median	80% CI	
TAC	10.0			10.6			7.04			9.1		
MSY	10.4	9.4	14.5	11.9	10.4	13.4	6.4	5.7	7.5	8.5	7.1	9.7
OY	9.9	8.8	13.9	10.6	9.3	12.2	6.1	5.4	7.1	7.6	6.2	8.8
MFMT	0.40	0.32	0.48	0.39	0.32	0.48	0.40	0.38	0.42	0.53	0.41	0.69
SS_{MSY}	5.2	4.7	7.1	6.42	5.7	7.1	13.7	12.2	15.8	19.1	17.5	20.7
MSST	4.4	4.0	6.1	5.4	5.0	6.0	9.6	8.5	11.1	13.4	12.3	14.5

Table 9. Probabilities of the fishing mortality rate and spawning stock exceeding targets and threshold for projection of TAC and median values of MSY and OY under average recruitment conditions. See Table 7 for acronym definitions.

Atlantic King Mackerel

	Current TAC 10.0 Mlbs			MSY 10.4 Mlbs			OY 9.9 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	39%	0%		47%	1%		36%	0%	
2002	38%	1%		49%	2%		36%	0%	
2003	39%	2%		49%	3%		36%	2%	
2004	37%	3%		47%	4%		34%	2%	
2005	41%	5%		47%	8%		38%	4%	
2006	41%	6%		47%	11%		39%	5%	
2007	40%	7%		48%	13%		38%	7%	
2008	43%	9%		52%	16%		41%	7%	
2009	45%	11%		54%	19%		42%	9%	
2010	44%	11%		54%	20%		43%	11%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	15%	0%	0%	17%	0%	0%	15%	0%	0%
2002	19%	0%	0%	23%	0%	0%	19%	0%	0%
2003	25%	0%	0%	29%	0%	0%	24%	0%	0%
2004	29%	1%	0%	35%	2%	0%	27%	1%	0%
2005	32%	3%	0%	38%	4%	0%	31%	2%	0%
2006	34%	4%	1%	40%	6%	2%	33%	4%	1%
2007	36%	6%	2%	43%	10%	3%	34%	5%	1%
2008	39%	8%	2%	46%	13%	5%	37%	8%	2%
2009	40%	10%	3%	49%	15%	6%	36%	10%	3%
2010	41%	11%	4%	50%	17%	8%	38%	9%	3%

Gulf King Mackerel

	Current TAC 10.6 Mlbs			MSY 11.9 Mlbs			OY 10.6 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	93%	48%		98%	69%		93%	48%	
2002	92%	48%		97%	72%		92%	48%	
2003	86%	41%		95%	62%		86%	41%	
2004	85%	39%		93%	62%		85%	39%	
2005	85%	39%		94%	65%		85%	39%	
2006	81%	36%		93%	62%		81%	36%	
2007	79%	35%		92%	63%		79%	35%	
2008	76%	31%		91%	61%		76%	31%	
2009	75%	29%		91%	60%		75%	29%	
2010	71%	28%		89%	60%		71%	28%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	100%	73%	31%	100%	73%	31%	100%	73%	31%
2002	99%	69%	32%	100%	73%	36%	99%	69%	32%
2003	97%	63%	31%	98%	72%	38%	97%	63%	31%
2004	94%	58%	29%	97%	68%	38%	94%	58%	29%
2005	90%	54%	26%	95%	67%	39%	90%	54%	26%
2006	88%	47%	24%	93%	66%	39%	88%	47%	24%
2007	85%	45%	23%	91%	65%	39%	85%	45%	23%
2008	83%	41%	22%	90%	64%	39%	83%	41%	22%
2009	80%	37%	21%	90%	64%	36%	80%	37%	21%
2010	76%	35%	19%	89%	63%	36%	76%	35%	19%

Table 9. (continued …)

Atlantic Spanish Mackerel

	Current TAC 7.04 Mlbs			MSY 6.4 Mlbs			OY 6.1 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	46%	15%		32%	6%		25%	5%	
2002	51%	22%		35%	11%		29%	8%	
2003	58%	27%		38%	14%		30%	10%	
2004	61%	31%		43%	18%		32%	12%	
2005	63%	36%		45%	19%		33%	15%	
2006	66%	41%		45%	22%		37%	16%	
2007	68%	44%		47%	26%		39%	18%	
2008	70%	46%		48%	27%		40%	21%	
2009	72%	49%		50%	29%		41%	22%	
2010	75%	53%		54%	31%		42%	23%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	20%	3%	0%	15%	2%	0%	14%	1%	0%
2002	29%	7%	1%	23%	4%	1%	20%	3%	1%
2003	36%	14%	3%	31%	10%	1%	25%	7%	1%
2004	45%	20%	8%	32%	12%	2%	28%	10%	2%
2005	50%	25%	12%	37%	16%	6%	30%	12%	3%
2006	53%	31%	17%	40%	20%	8%	33%	14%	5%
2007	58%	35%	21%	42%	22%	11%	35%	16%	7%
2008	59%	40%	25%	43%	25%	15%	38%	20%	9%
2009	64%	43%	29%	46%	27%	17%	38%	22%	12%
2010	67%	46%	33%	50%	28%	18%	41%	22%	14%

Gulf Spanish Mackerel

	Current TAC 9.1 Mlbs			MSY 8.5 Mlbs			OY 7.6 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	65%	21%		57%	17%		44%	10%	
2002	69%	24%		60%	18%		45%	11%	
2003	73%	27%		61%	19%		45%	12%	
2004	74%	33%		62%	21%		45%	12%	
2005	77%	35%		64%	24%		44%	13%	
2006	78%	39%		65%	27%		43%	14%	
2007	78%	41%		68%	27%		44%	13%	
2008	79%	43%		68%	29%		43%	14%	
2009	81%	45%		68%	30%		43%	14%	
2010	82%	47%		68%	31%		44%	13%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	48%	11%	2%	46%	10%	2%	41%	9%	1%
2002	52%	16%	3%	46%	13%	3%	41%	9%	2%
2003	58%	19%	5%	51%	15%	4%	38%	11%	2%
2004	60%	23%	7%	52%	17%	4%	38%	12%	2%
2005	64%	29%	10%	53%	20%	6%	40%	13%	2%
2006	66%	31%	12%	54%	23%	7%	40%	12%	3%
2007	68%	34%	15%	56%	22%	9%	40%	13%	4%
2008	71%	37%	16%	57%	25%	10%	39%	14%	4%
2009	72%	39%	20%	59%	28%	10%	39%	13%	4%
2010	71%	41%	21%	58%	30%	12%	40%	15%	5%

Table 10. Probabilities of the fishing mortality rate and spawning stock exceeding targets and threshold for projection of TAC and median values of MSY and OY under low recruitment conditions. See Table 7 for acronym definitions.

Atlantic King Mackerel: low recruitment scenario

	Current TAC 10.0 Mlbs			MSY 10.4 Mlbs			OY 9.9 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	42%	1%		51%	1%		40%	1%	
2002	51%	2%		58%	4%		48%	2%	
2003	60%	9%		66%	17%		59%	8%	
2004	65%	21%		70%	33%		62%	19%	
2005	71%	40%		75%	51%		71%	37%	
2006	78%	58%		80%	62%		77%	56%	
2007	81%	67%		83%	72%		80%	64%	
2008	86%	77%		88%	80%		86%	76%	
2009	90%	83%		91%	85%		90%	82%	
2010	92%	87%		93%	90%		92%	87%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	34%	0%	0%	23%	0%	0%	21%	0%	0%
2002	52%	1%	0%	46%	0%	0%	43%	0%	0%
2003	65%	8%	1%	64%	7%	0%	60%	5%	0%
2004	75%	32%	8%	75%	31%	7%	72%	21%	4%
2005	83%	56%	31%	84%	57%	32%	80%	50%	22%
2006	90%	70%	56%	90%	72%	58%	88%	67%	50%
2007	93%	82%	71%	93%	83%	73%	92%	79%	67%
2008	97%	89%	83%	97%	91%	84%	97%	88%	81%
2009	99%	94%	90%	99%	94%	91%	98%	93%	88%
2010	99%	97%	94%	99%	97%	95%	99%	97%	94%

Gulf King Mackerel: low recruitment scenario

	Current TAC 10.6 Mlbs			MSY 11.9 Mlbs			OY 10.6 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	93%	48%		98%	69%		93%	48%	
2002	92%	48%		97%	72%		92%	48%	
2003	87%	42%		95%	62%		87%	42%	
2004	88%	46%		95%	68%		88%	46%	
2005	89%	56%		97%	79%		89%	56%	
2006	92%	63%		98%	85%		92%	63%	
2007	96%	78%		99%	90%		96%	78%	
2008	97%	84%		100%	94%		97%	84%	
2009	98%	88%		100%	97%		98%	88%	
2010	100%	95%		100%	100%		100%	95%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	100%	73%	31%	100%	73%	31%	100%	73%	31%
2002	99%	69%	32%	100%	73%	36%	99%	69%	32%
2003	97%	64%	32%	98%	72%	38%	97%	64%	32%
2004	96%	64%	33%	98%	74%	43%	96%	64%	33%
2005	96%	66%	38%	98%	81%	51%	96%	66%	38%
2006	96%	77%	48%	99%	87%	62%	96%	77%	48%
2007	99%	86%	62%	100%	93%	76%	99%	86%	62%
2008	100%	93%	74%	100%	97%	85%	100%	93%	74%
2009	100%	97%	83%	100%	100%	93%	100%	97%	83%
2010	100%	99%	91%	100%	100%	97%	100%	99%	91%

Table 10. (continued …)

Atlantic Spanish Mackerel: low recruitment scenario

	Current TAC 7.04 Mlbs			MSY 6.4 Mlbs			OY 6.1 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	51%	17%		35%	9%		29%	6%	
2002	65%	31%		48%	19%		39%	13%	
2003	79%	48%		65%	31%		54%	23%	
2004	89%	67%		76%	45%		69%	35%	
2005	93%	76%		83%	57%		75%	44%	
2006	97%	86%		90%	69%		85%	57%	
2007	99%	93%		95%	82%		92%	70%	
2008	99%	95%		97%	87%		94%	79%	
2009	100%	98%		99%	92%		97%	87%	
2010	100%	99%		99%	95%		98%	90%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	20%	3%	0%	15%	2%	0%	14%	1%	0%
2002	40%	11%	1%	33%	8%	1%	28%	7%	1%
2003	62%	28%	8%	51%	18%	4%	45%	15%	2%
2004	77%	48%	20%	69%	33%	11%	63%	28%	8%
2005	89%	65%	35%	82%	49%	23%	77%	42%	15%
2006	95%	81%	52%	90%	67%	34%	86%	57%	27%
2007	98%	90%	70%	95%	81%	49%	93%	72%	39%
2008	99%	94%	83%	98%	90%	62%	95%	84%	52%
2009	99%	98%	90%	99%	92%	78%	98%	89%	63%
2010	100%	99%	95%	99%	96%	85%	99%	93%	76%

Gulf Spanish Mackerel: low recruitment scenario

	Current TAC 9.1 Mlbs			MSY 8.5 Mlbs			OY 7.6 Mlbs		
	Probability F greater than								
FYear	FOY	FMSY		FOY	FMSY		FOY	FMSY	
2001	66%	21%		58%	18%		45%	11%	
2002	73%	28%		64%	21%		49%	14%	
2003	83%	41%		71%	28%		54%	17%	
2004	88%	53%		81%	39%		60%	20%	
2005	93%	63%		87%	50%		70%	29%	
2006	95%	73%		91%	59%		75%	35%	
2007	97%	80%		94%	67%		81%	42%	
2008	98%	86%		97%	74%		85%	48%	
2009	99%	91%		98%	80%		90%	53%	
2010	99%	94%		98%	85%		91%	59%	
	Probability Spawning stock less than								
FYear	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST	SSOY	SSMSY	MSST
2001	48%	11%	2%	46%	10%	2%	41%	9%	1%
2002	61%	21%	4%	58%	19%	4%	51%	14%	3%
2003	79%	35%	11%	73%	27%	9%	63%	21%	4%
2004	86%	52%	19%	82%	43%	14%	76%	29%	9%
2005	93%	69%	30%	90%	57%	21%	83%	40%	14%
2006	96%	77%	40%	93%	70%	30%	88%	51%	19%
2007	98%	85%	52%	96%	76%	40%	91%	60%	22%
2008	99%	90%	64%	98%	83%	48%	95%	66%	30%
2009	99%	94%	73%	99%	90%	59%	97%	73%	36%
2010	99%	96%	81%	99%	92%	65%	97%	78%	42%

Table 11. Recruitment indices for the four mackerel migratory groups. The Atlantic indices come from Seamap frequency of occurrence, shaded areas represent updated values since last assessment. The Gulf indices come from total bycatch in the shrimp trawl fishery (GLM values) divided by total effort.

Ages	0	0	0	0-1	0-2	0-2
Year	Atl King	GLM Gulf King	Delta Gulf King	Atl Spanish	GLM Gulf Spanish	Delta Gulf Spanish
1981		0.0907	0.1508			
1982		0.0877	0.0783			
1983		0.0796				
1984		0.1137	0.3934		1.871	1.6308
1985		0.1071	0.1547		1.546	0.4728
1986		0.07	0.101		1.731	0.9763
1987		0.1448	0.251		2.144	0.4163
1988		0.1251	0.2374		2.708	1.4716
1989	0.164	0.2532	0.4764	0.255	2.916	1.5096
1990	0.294	0.1803	0.3513	0.454	2.645	1.3112
1991	0.152	0.2092	0.3524	0.496	2.908	1.2555
1992	0.123	0.1054	0.1549	0.471	2.744	1.7835
1993	0.112	0.2109	0.4284	0.283	3.156	2.8839
1994	0.130	0.2236	0.4615	0.397	2.044	1.0205
1995	0.256	0.2562	0.6033	0.419	2.018	0.984
1996	0.274	0.1348	0.2264	0.379	1.946	0.629
1997	0.132	0.1585	0.2191	0.231	1.689	0.3644
1998	0.204	0.1658	0.2346	0.313	2.052	0.6029
1999	0.217	0.1131	0.3022	0.332	1.648	0.1191
2000	0.143			0.458		

Table 12. Updated indices of abundance for king mackerel migratory groups from the FDEP Florida trip ticket program (Provided by R. Muller) with 95% confidence intervals. Last column show the indices used in the latest stock assessment.

King Mackerel FDEP CPUE indices

	Year	CPUE	Upp CI	Low CI	2000 SA index
Gulf King Panhandle FL	1985	17.39	22.84	12.97	17.85
	1986	21.25	28.21	15.65	26.57
	1987	22.24	27.19	17.99	24.17
	1988	18.54	22.29	15.28	18.77
	1989	19.35	24.10	15.32	23.31
	1990	26.37	31.58	21.83	28.63
	1991	29.03	33.95	24.66	39.61
	1992	38.38	44.99	32.52	38.29
	1993	32.13	37.98	26.97	37.97
	1994	38.25	44.59	32.60	44.26
	1995	34.18	40.18	28.86	36.17
	1996	55.09	63.97	47.16	67.14
	1997	74.32	86.03	63.83	62.18
	1998	46.02	53.97	38.98	
	1999	64.04	74.38	54.80	
Gulf King Southern FL	1985	36.77	42.79	31.40	31.39
	1986	35.75	40.94	31.06	31.06
	1987	48.42	54.90	42.52	42.30
	1988	69.47	82.81	57.79	60.22
	1989	65.70	73.70	58.36	56.47
	1990	84.93	93.84	76.66	73.45
	1991	82.52	91.66	74.06	72.08
	1992	167.11	183.04	152.2	143.32
	1993	103.81	114.61	93.78	88.78
	1994	56.94	64.56	50.01	49.82
	1995	83.83	93.97	74.53	76.35
	1996	109.23	120.19	99.02	94.41
	1997	85.48	95.12	76.57	
	1998	105.00	119.79	91.61	
	1999	57.09	65.52	49.48	
South Atlantic King (*1998 last SA)	1985	68.87	72.23	65.63	217.69*
	1986	76.47	80.22	72.86	231.687
	1987	76.10	79.85	72.47	256.312
	1988	88.59	93.13	84.22	305.969
	1989	85.50	89.87	81.30	267.018
	1990	71.25	74.78	67.85	220.932
	1991	66.66	69.87	63.57	195.676
	1992	61.04	64.02	58.17	202.631
	1993	61.40	64.36	58.54	202.508
	1994	60.00	62.89	57.21	192.744
	1995	57.11	59.94	54.38	192.336
	1996	71.09	74.59	67.73	217.576
	1997	71.23	74.64	67.94	223.916
	1998	65.91	69.05	62.87	
	1999	68.21	71.55	65.00	

Table 13. Updated indices of abundance for Spanish mackerel migratory groups from the FDEP Florida trip ticket program (Provided by R. Muller) with 95% confidence intervals. Last column show the indices used in the latest stock assessment.

Spanish Mackerel FDEP CPUE indices

	Year	CPUE	Upp CI	Low CI	1998 SA index
Gulf: Jul - Dec & Trips >= 500 lbs Two areas Escambia - Dixie and Levy - Monroe	1985	1622.78	1844.46	1421.4	2121.13
	1986	1063.26	1227.23	916.08	1013.14
	1987	1733.22	2032.07	1468.1	1872.27
	1988	934.11	1050.06	827.92	885.87
	1989	708.15	801.22	623.33	646.60
	1990	1039.47	1170.27	919.81	973.10
	1991	1463.13	1608.92	1327.3	1488.85
	1992	1200.03	1325.66	1083.4	1231.75
	1993	1268.82	1421.05	1129.0	1279.80
	1994	1119.51	1238.15	1009.4	1142.13
	1995	616.80	1077.27	321.02	626.19
	1996	688.70	977.47	468.45	566.16
	1997	890.76	1394.34	536.22	
	1998	1339.93	1740.71	1011.8	
	1999	625.78	1013.72	360.32	
Atlantic: All months-counties & 500 lb minimum	1985	2414.72	2719.93	2135.6	9.54
	1986	1631.23	1853.28	1429.5	12.80
	1987	1632.38	1838.10	1444.2	17.82
	1988	1193.32	1350.93	1049.7	18.26
	1989	945.34	1058.01	841.80	21.92
	1990	792.53	885.85	706.68	16.96
	1991	798.45	890.95	713.26	14.12
	1992	787.68	874.81	707.14	18.74
	1993	676.24	749.00	608.84	30.07
	1994	704.40	779.71	634.61	29.13
	1995	849.75	947.18	759.93	25.66
	1996	989.56	1102.52	885.39	44.30
	1997	811.11	902.35	726.87	64.33
	1998	924.47	1027.14	829.59	
	1999	797.47	891.25	711.20	
Atlantic: All months-counties & NO minimum trip	1985	11.64	14.28	9.37	9.54
	1986	13.07	16.02	10.54	12.80
	1987	15.12	18.55	12.19	17.82
	1988	19.84	24.36	15.98	18.26
	1989	19.88	24.38	16.03	21.92
	1990	14.70	18.00	11.88	16.96
	1991	13.43	16.43	10.86	14.12
	1992	20.27	24.81	16.38	18.74
	1993	26.66	32.63	21.54	30.07
	1994	25.23	30.90	20.37	29.13
	1995	36.49	45.09	29.16	25.66
	1996	44.86	55.25	35.99	44.30
	1997	35.95	44.16	28.92	64.33
	1998	49.66	61.03	39.94	
	1999	40.74	50.34	32.57	

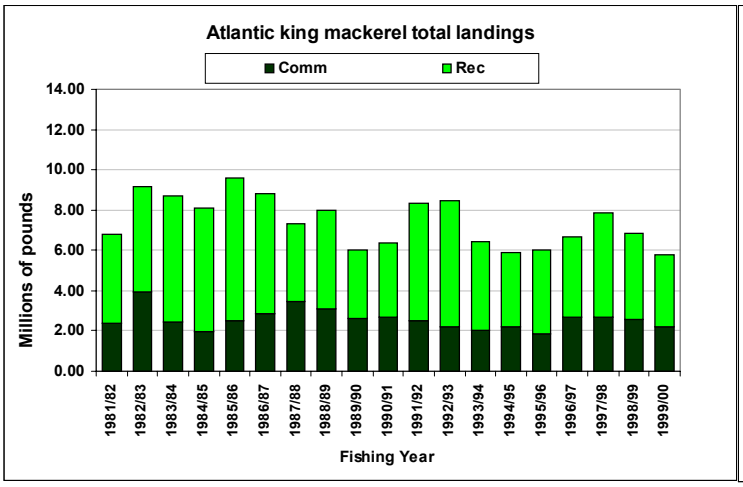


Figure 1 Atlantic king mackerel harvest levels by fishing sector.

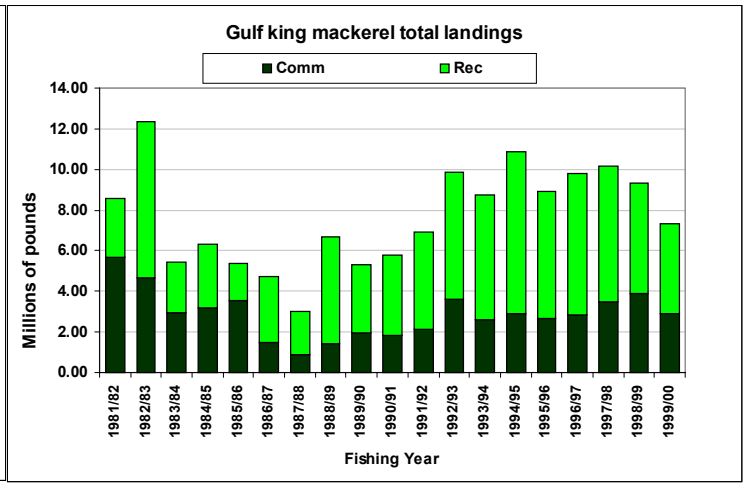


Figure 2 Gulf king mackerel harvest levels by fishing sector

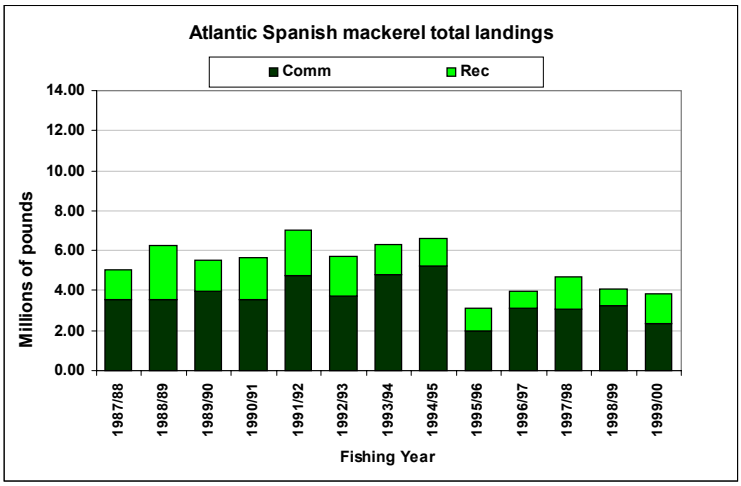


Figure 3 Atlantic Spanish mackerel harvest levels by fishing sector.

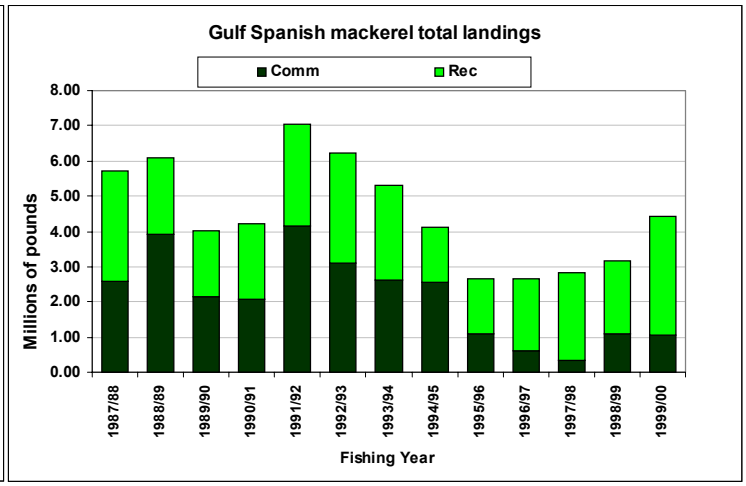


Figure 4 Gulf Spanish mackerel harvest levels by fishing sector.

ATLANTIC KING MACKEREL

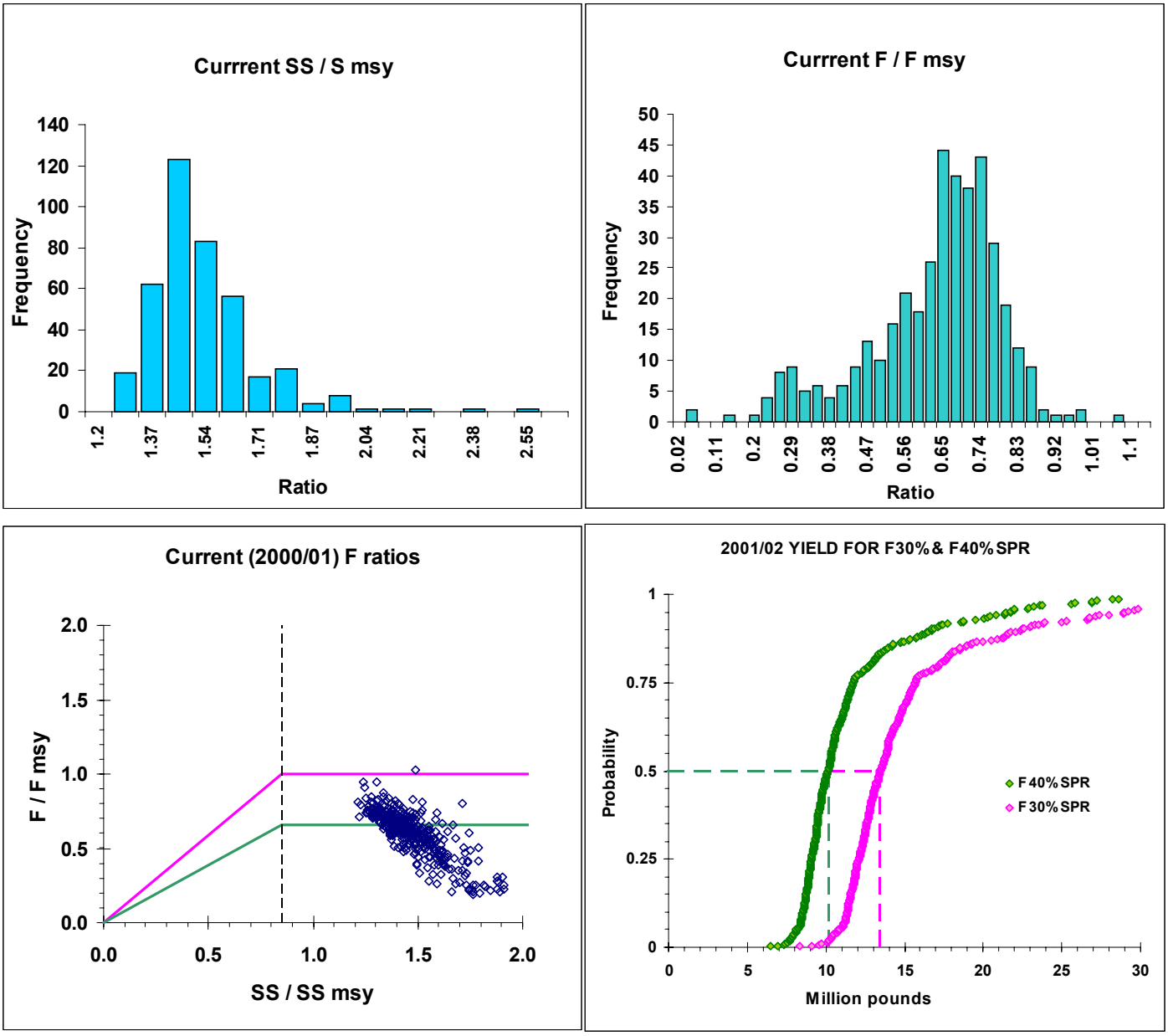


Figure 5 Projected Atlantic king mackerel stock status in FY2000 conditional on the most recent assessment results and recent estimated catches. Also indicated are projected FY2001 landings under $F_{30\%SPR}$ and $F_{40\%SPR}$ fishing rates.

GULF KING MACKEREL

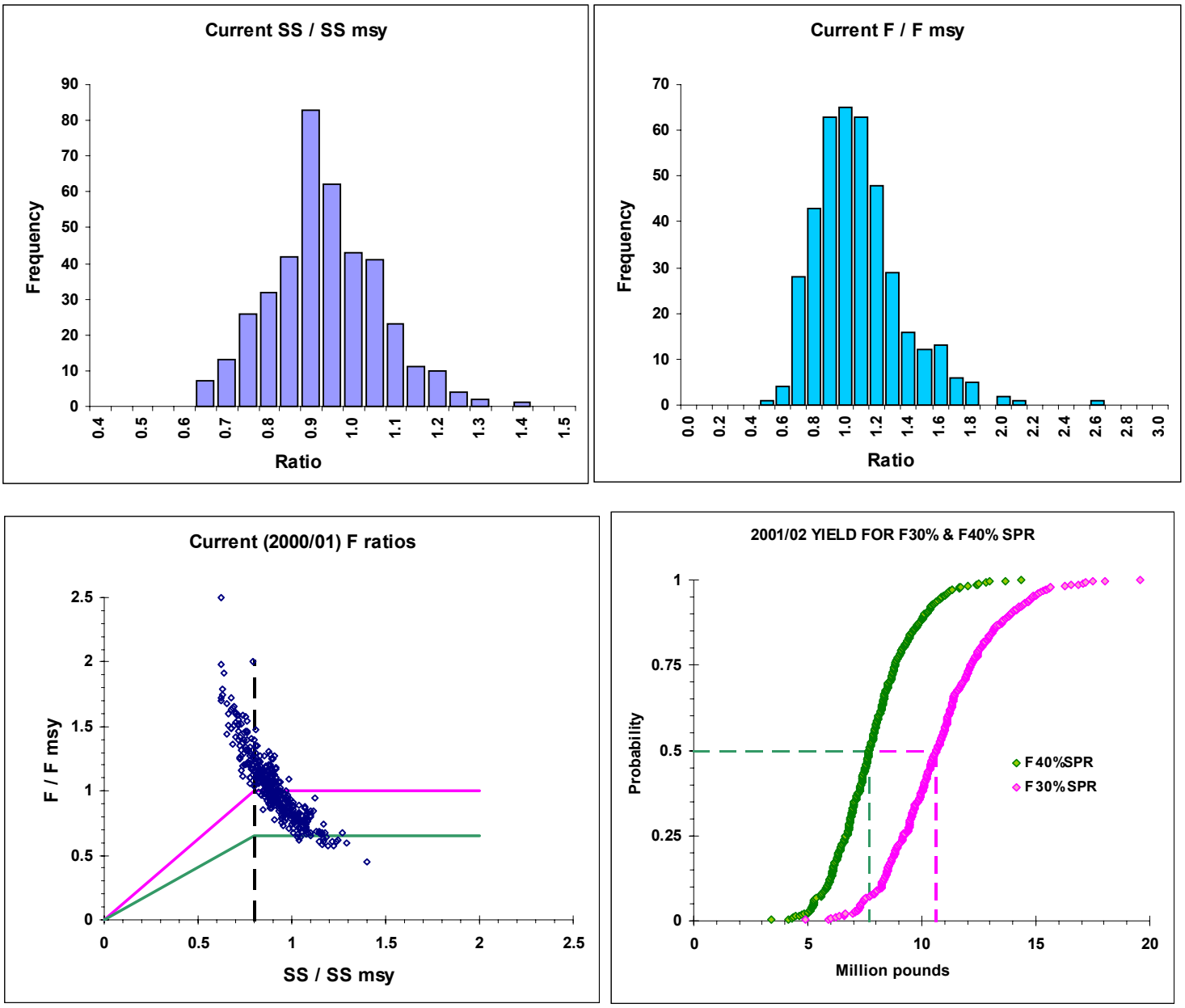


Figure 6 Projected Gulf king mackerel stock status in FY2000 conditional on the most recent assessment results and recent estimated catches. Also indicated are projected FY2001 landings under $F_{30\%SPR}$ and $F_{40\%SPR}$ fishing rates.

ATLANTIC SPANISH MACKEREL

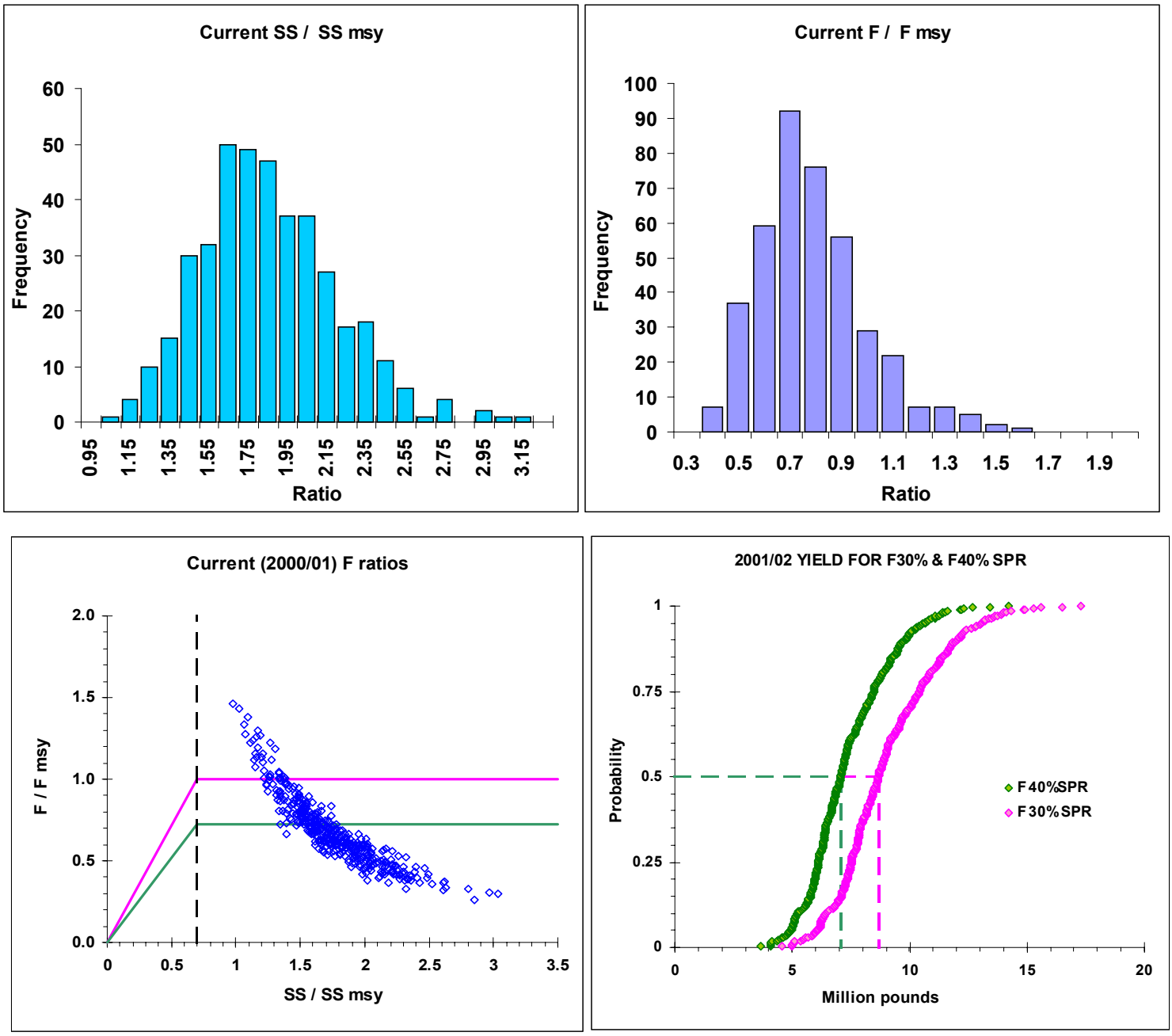
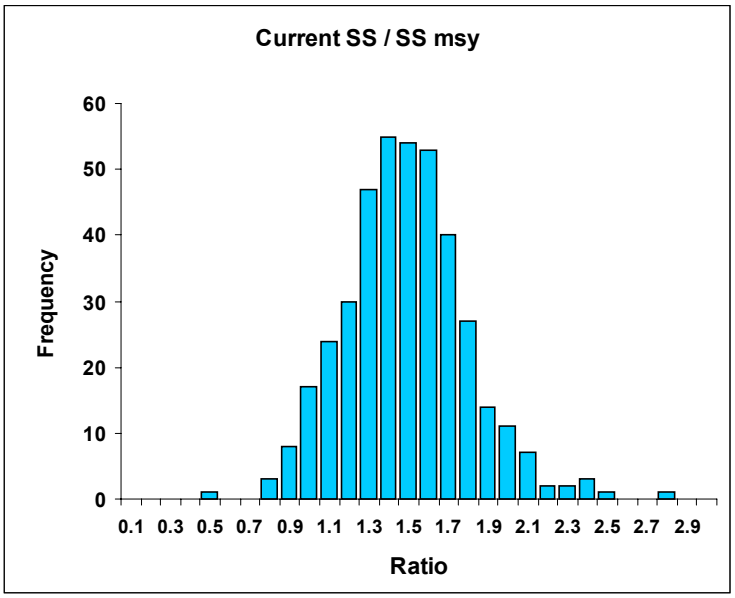
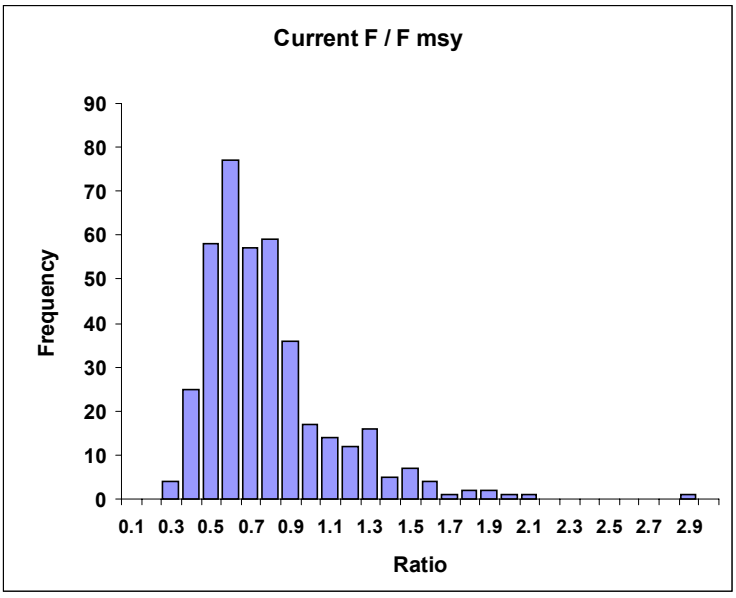
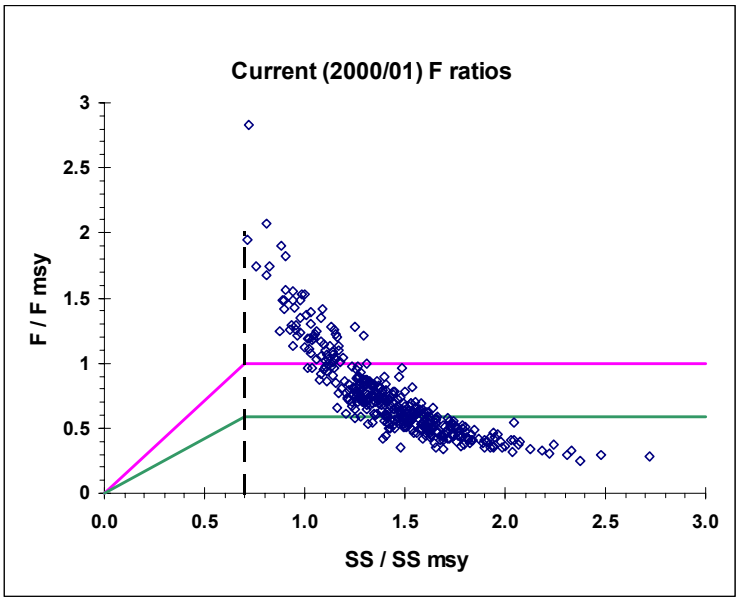


Figure 7 Projected Atlantic Spanish mackerel stock status in FY2000 conditional on the most recent assessment results and recent estimated catches. Also indicated are projected FY2001 landings under $F_{30\%SPR}$ and $F_{40\%SPR}$

GULF SPANISH MACKEREL







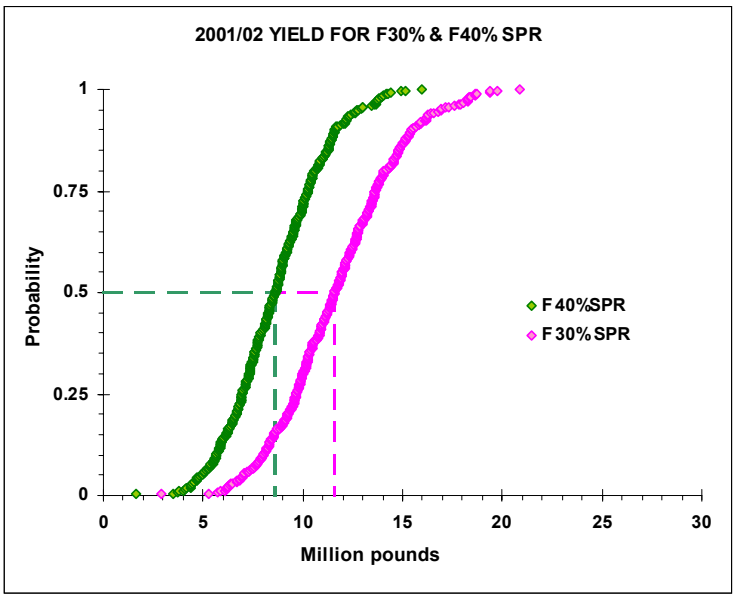


Figure 8 Projected Gulf Spanish mackerel stock status in FY2000 conditional on the most recent assessment results and recent estimated catches. Also indicated are projected FY2001 landings under $F_{30\%SPR}$ and $F_{40\%SPR}$ fishing rates.

ATLANTIC KING MACKEREL

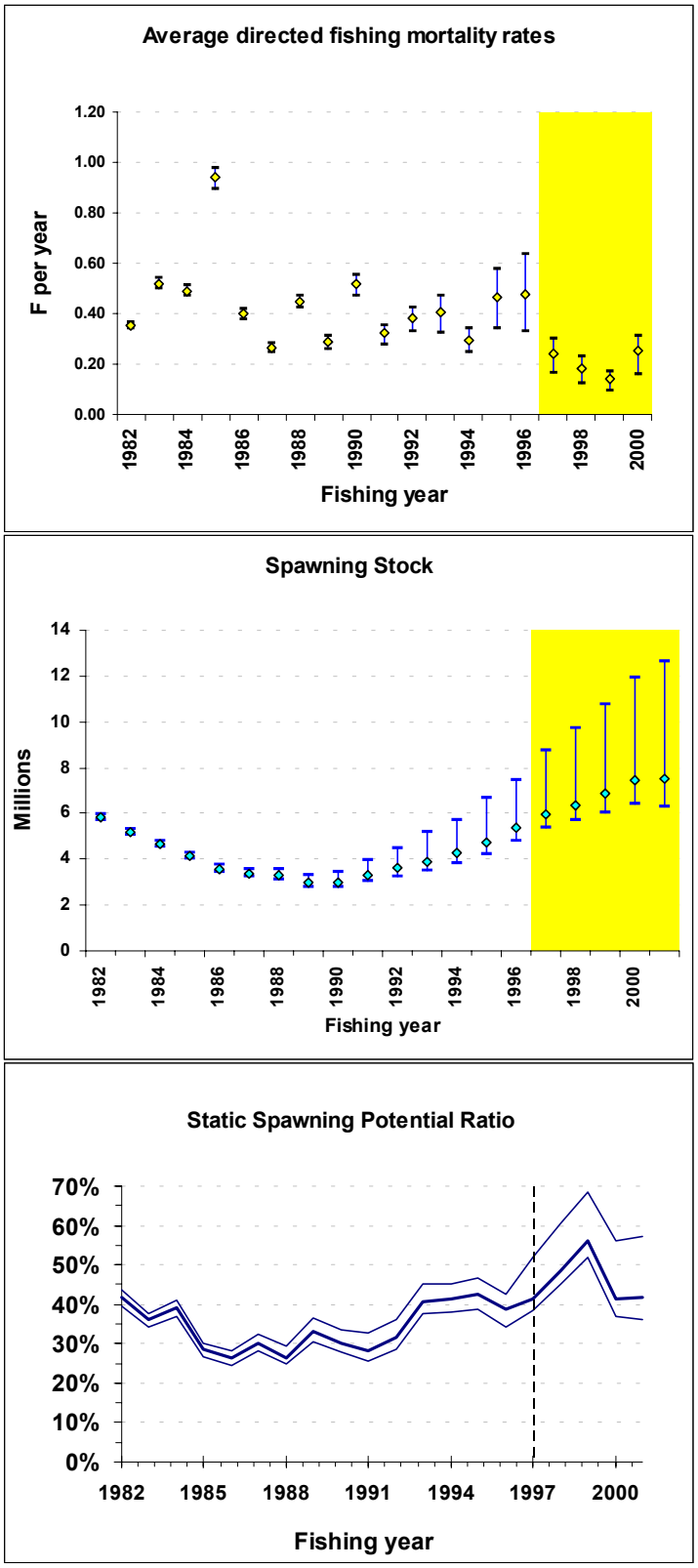


Figure 9 Estimated and projected time series of fishing rate, stock biomass and spawning potential ratio indicators for Atlantic king mackerel. Projected values are indicated by the shaded area and to the right of the vertical dashed line

GULF KING MACKEREL

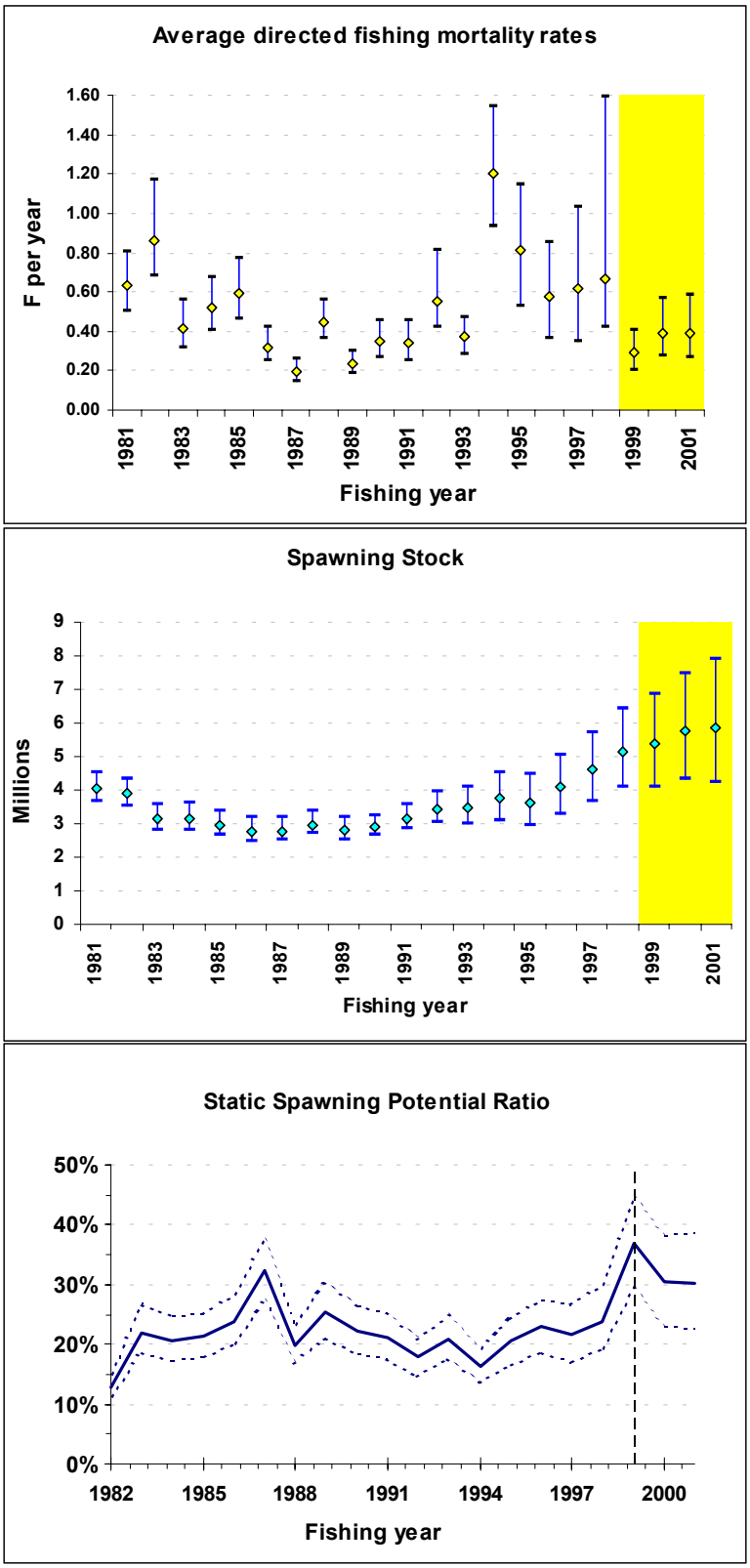


Figure 10 Estimated and projected time series of fishing rate, stock biomass and spawning potential ratio indicators for Gulf king mackerel. Projected values are indicated by the shaded area and to the right of the vertical dashed line

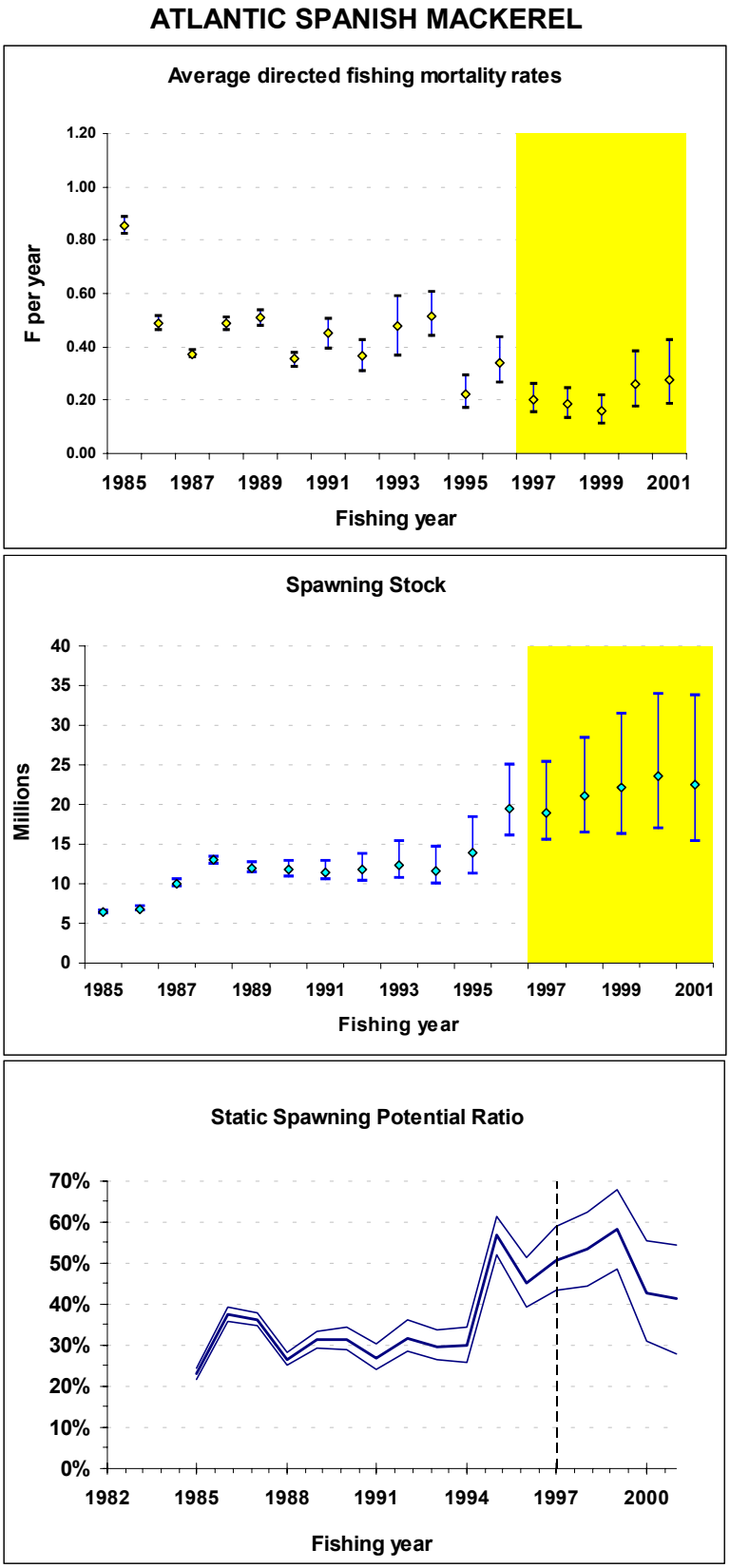


Figure 11 Estimated and projected time series of fishing rate, stock biomass and spawning potential ratio indicators for Atlantic Spanish mackerel. Projected values are indicated by the shaded area and to the right of the vertical dashed line

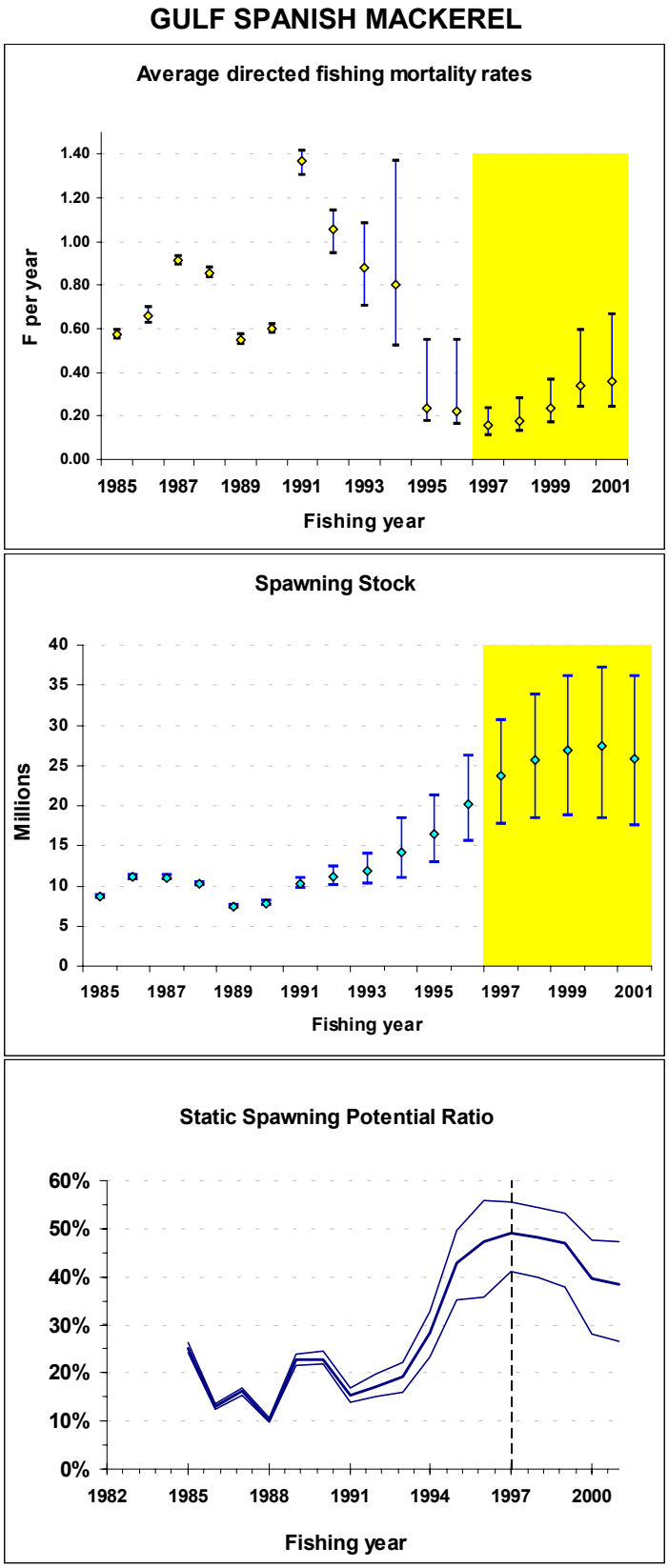


Figure 12 Estimated and projected time series of fishing rate, stock biomass and spawning potential ratio indicators for Gulf Spanish mackerel. Projected values are indicated by the shaded area and to the right of the vertical dashed line

ATLANTIC KING MACKEREL

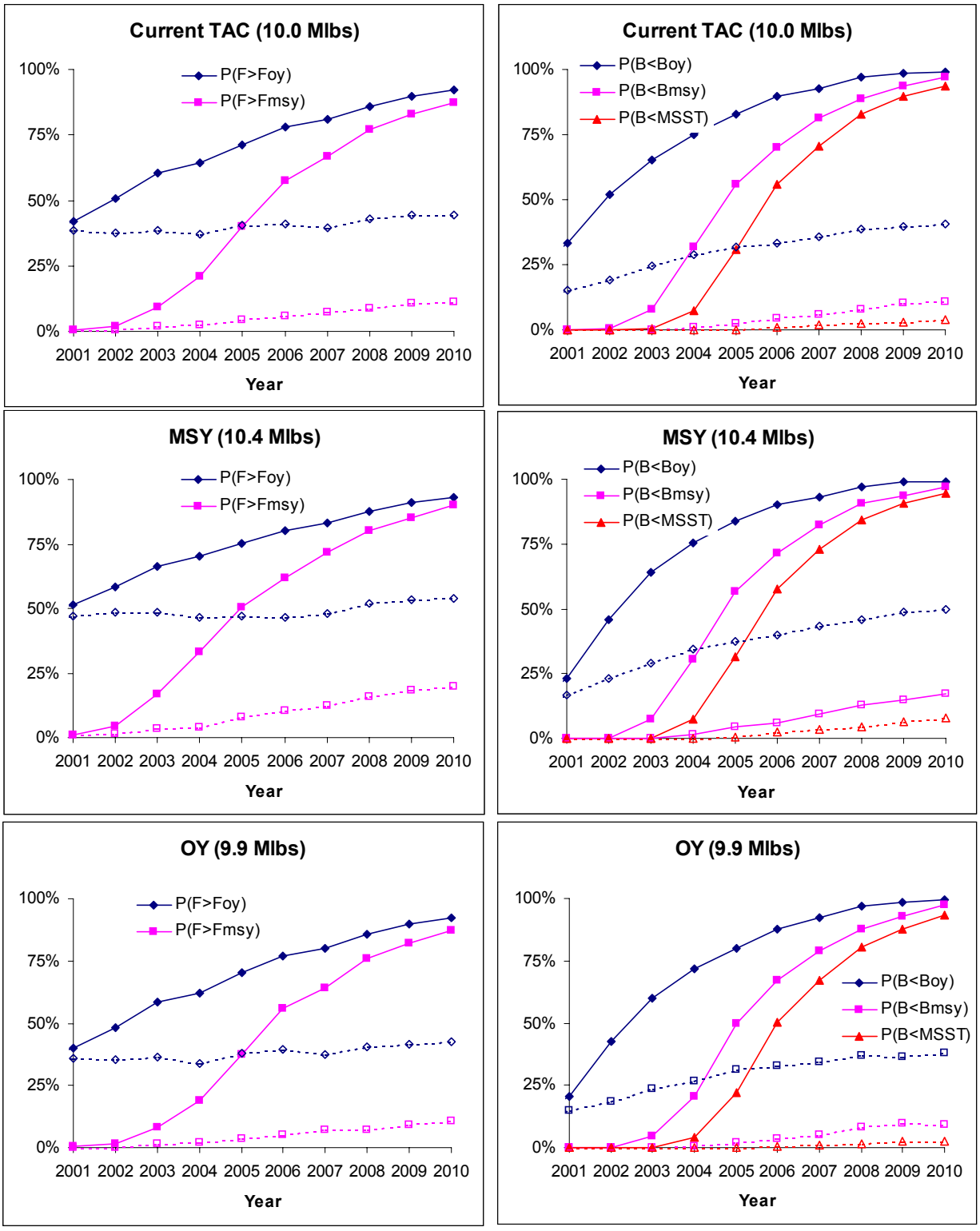


Figure 13 Probabilities of F and spawning stock exceeding thresholds and targets fro projections of TAC and median values of MSY and OY under average recruitment (dashed lines) and low recruitment (solid lines) scenarios. See Table 8 for acronym definitions

GULF KING MACKEREL

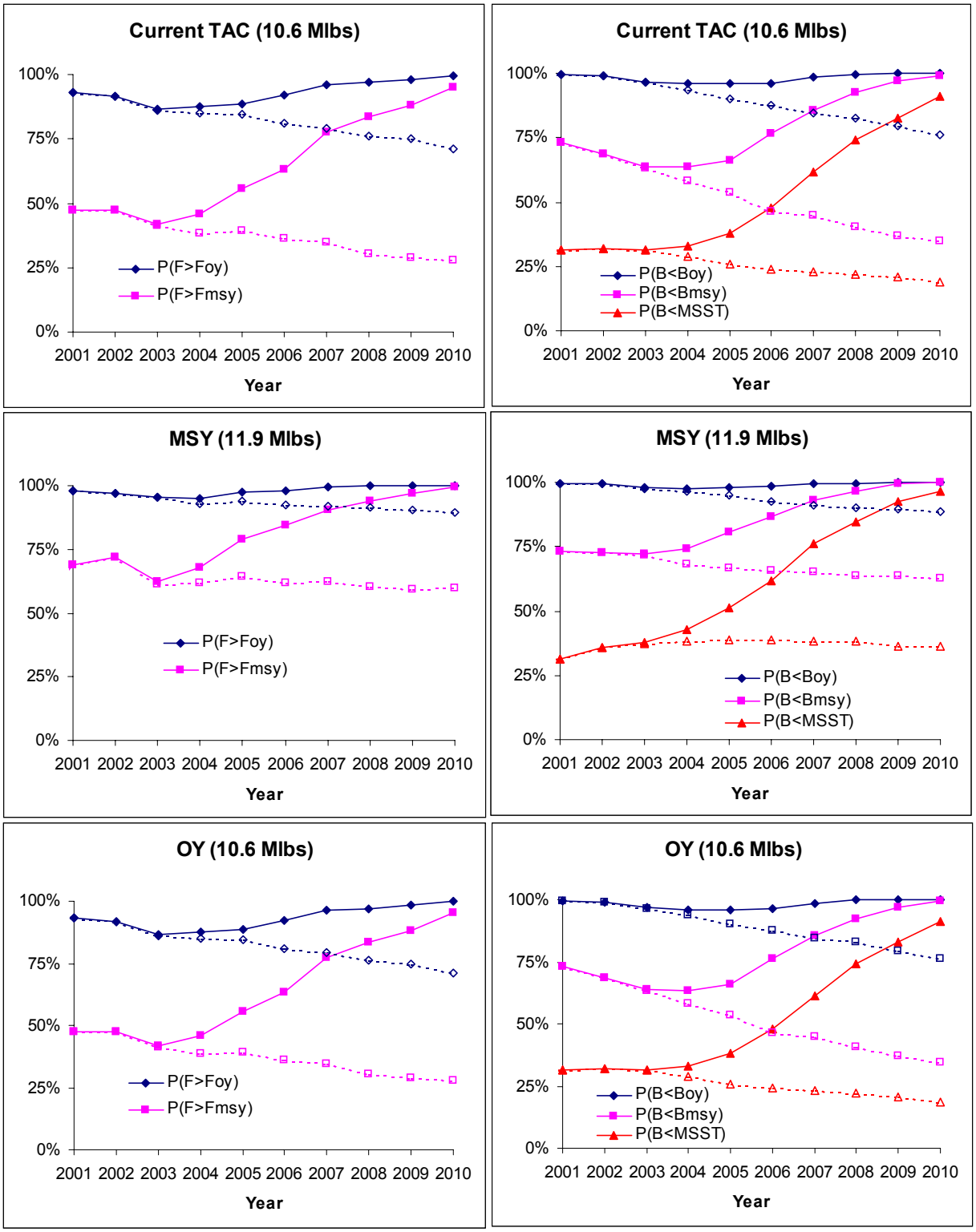


Figure 13 (continued …)

ATLANTIC SPANISH MACKEREL

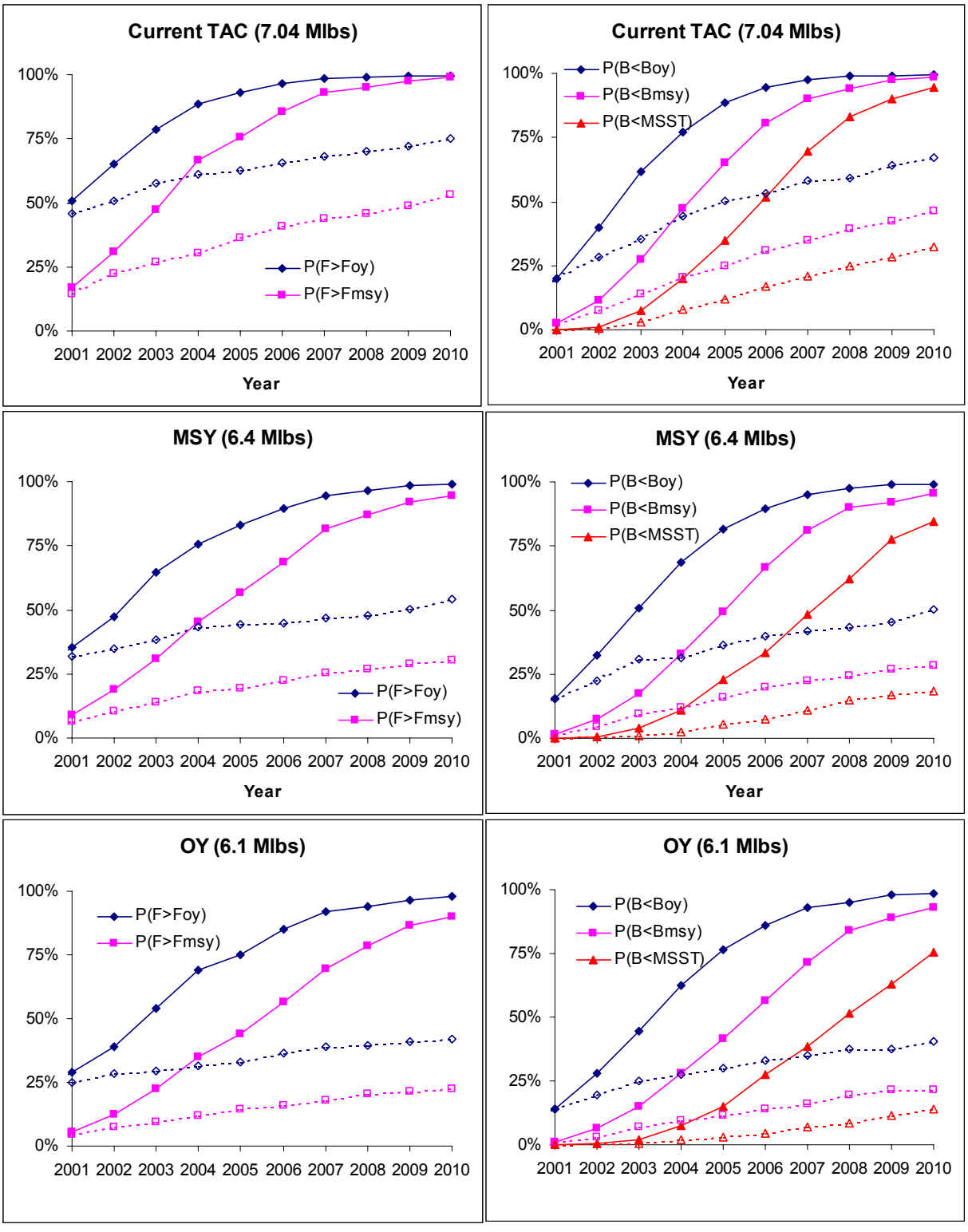
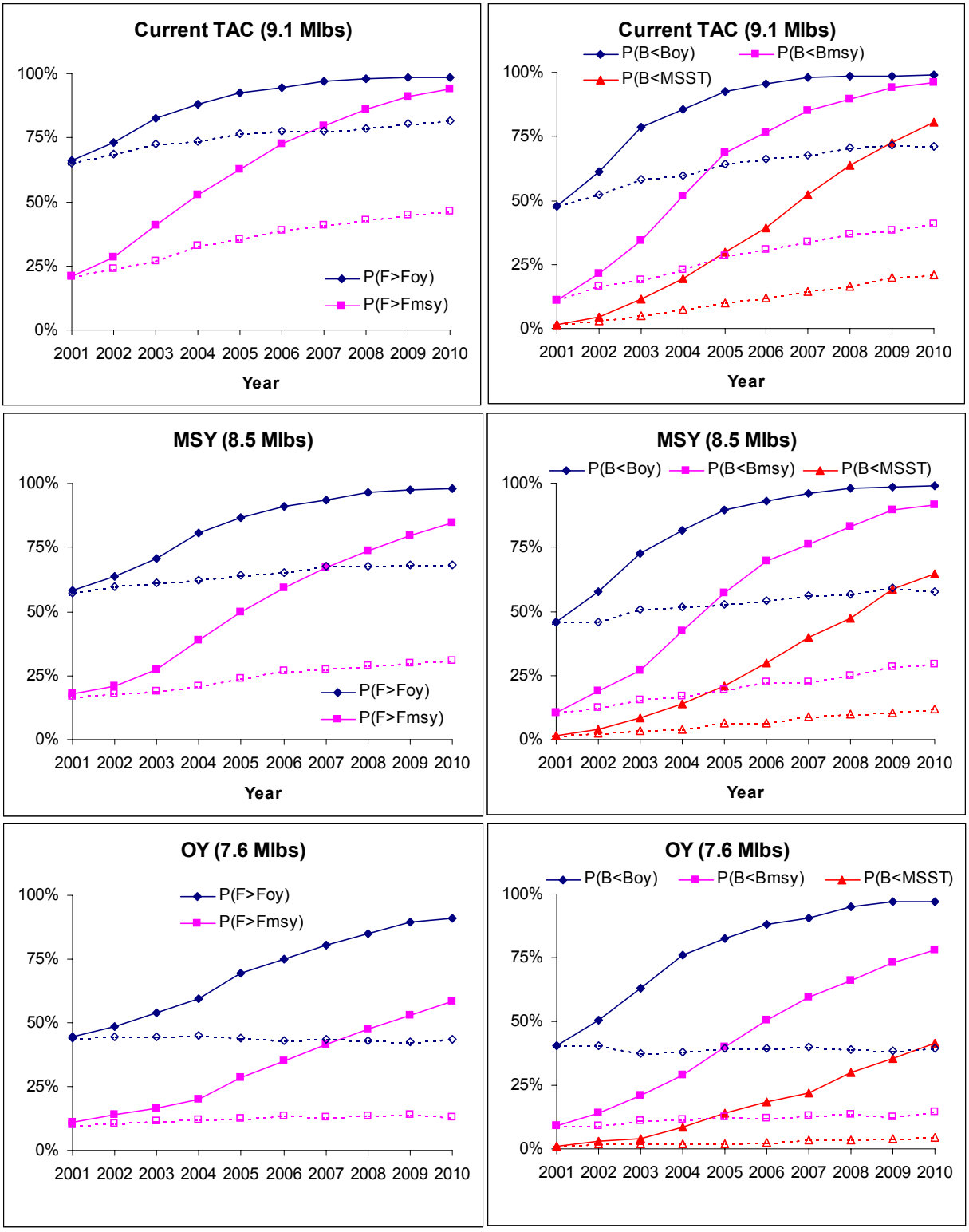


Figure 13 (continued …)

GULF SPANISH MACKEREL



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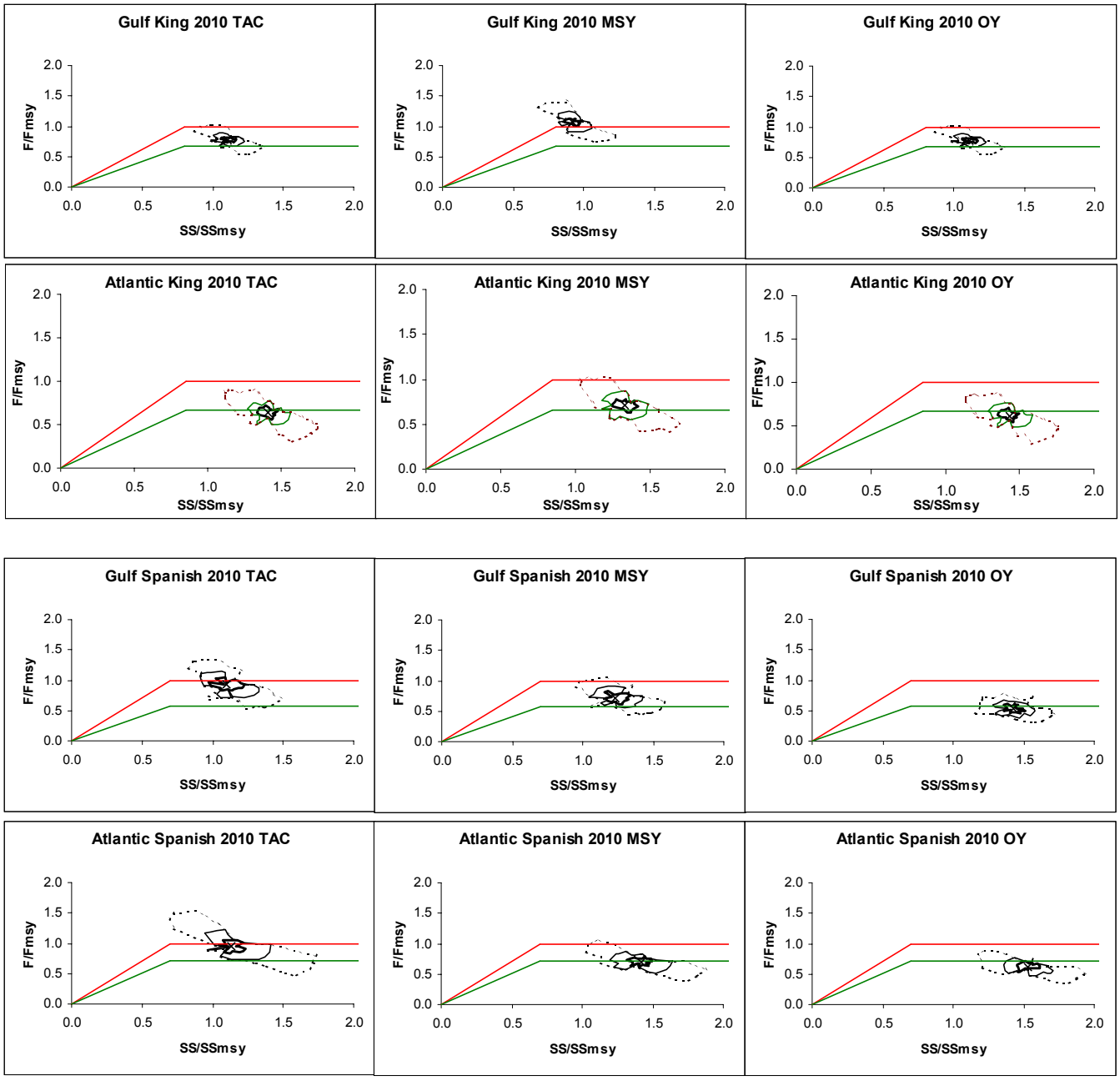

Figure 14 Resulting F and spawning stock ratios relative to MSY values for the four mackerel groups under three levels of projected catch in the year 2010. The lines enclose the 10th (bold), 25th (solid), and 50th (dashed) percentiles of the 400 bootstraps that are closest to the median values (denoted by a cross).

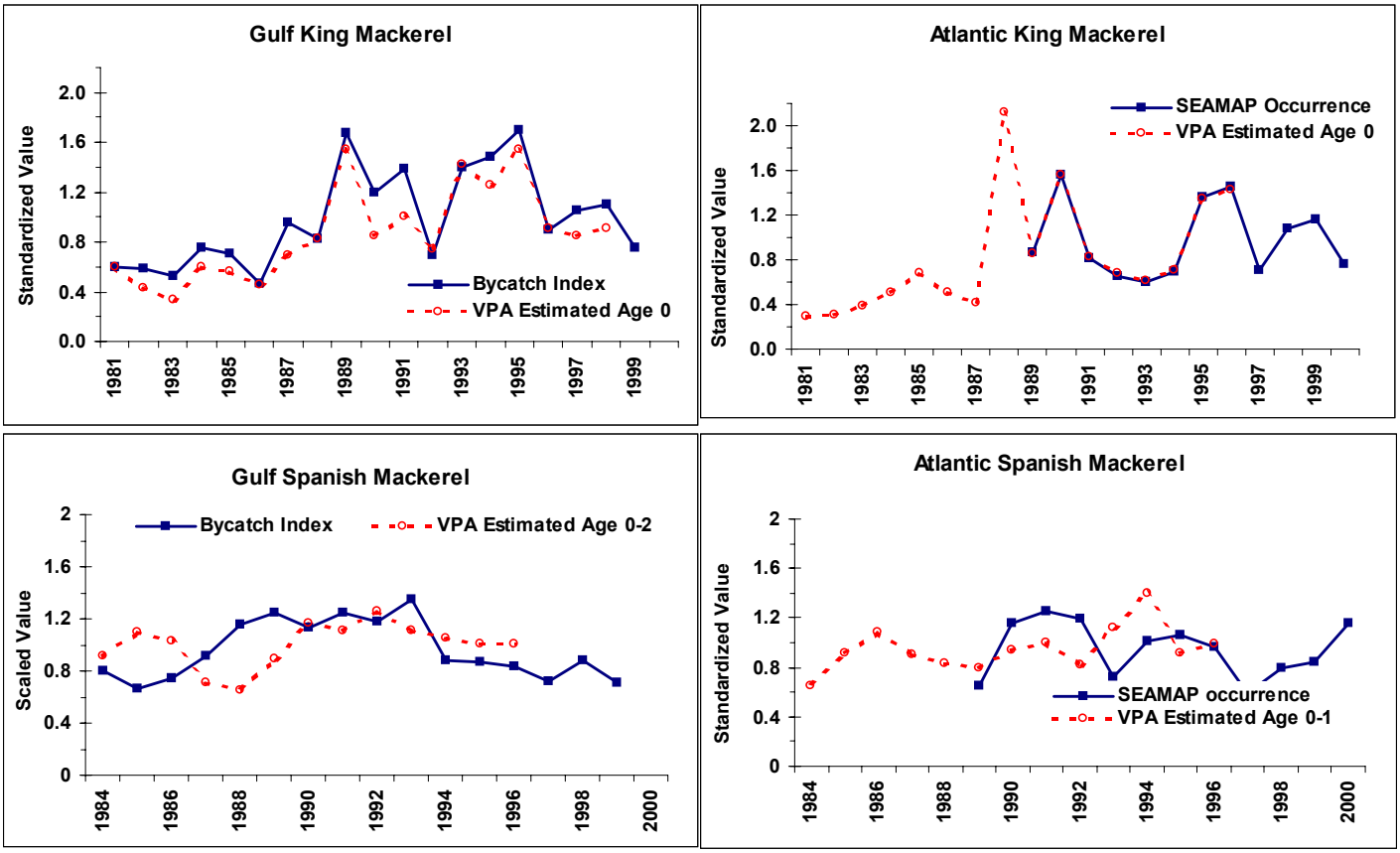

Figure 15. Recruitment indices for the four mackerel migratory groups. The Atlantic indices come from Seamap frequency of occurrence. The Gulf indices come from total bycatch in the shrimp trawl fishery (GLM values) divided by the total effort. Values are standardized to the mean of the overlapping years between comparable series.

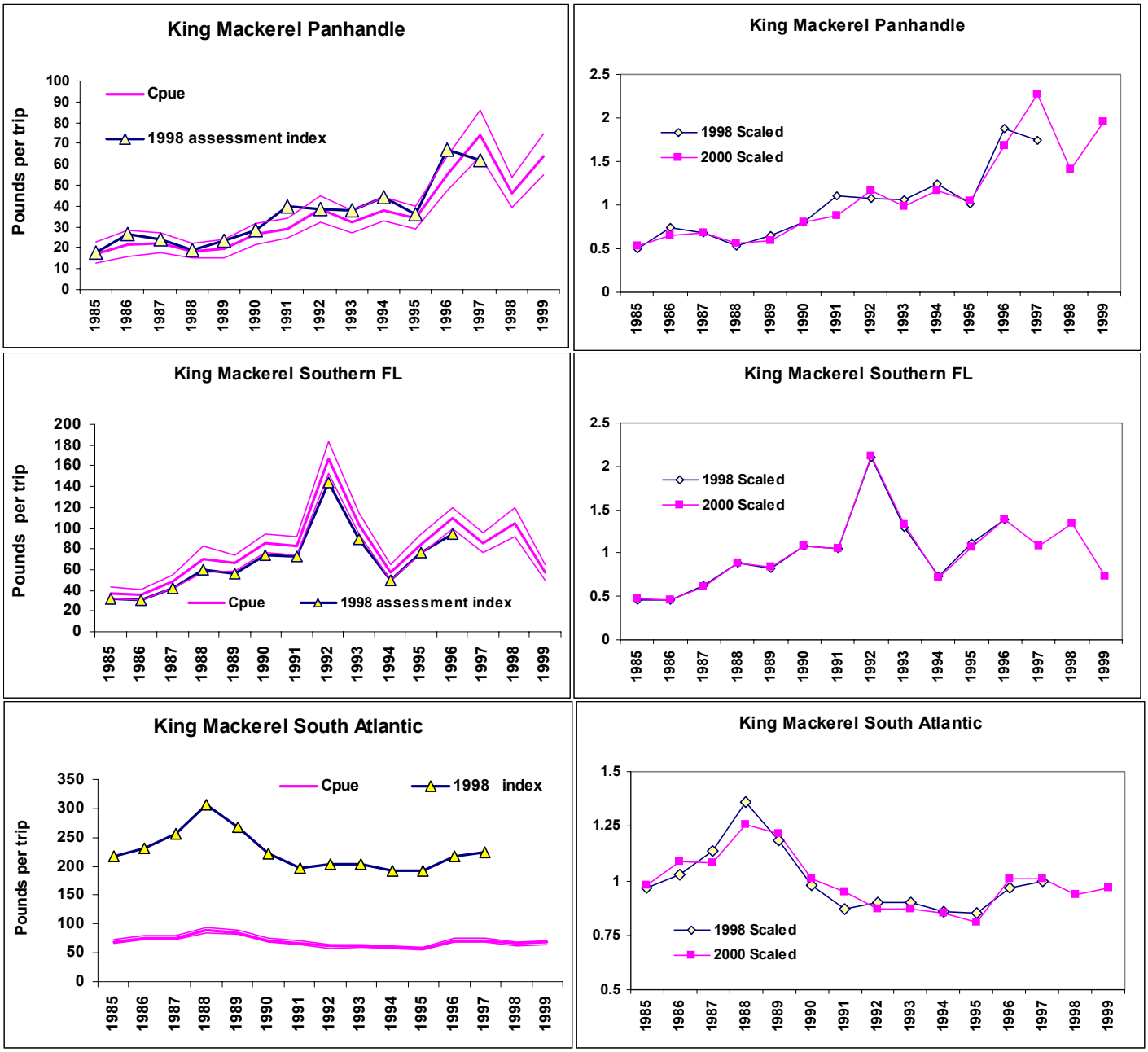

Figure 16. Indices of abundance for king mackerel migratory groups from the FDEP Florida trip ticket program. Left column shows standardized CPUE values and 95% CI, compared to the equivalent indices used in the last assessment. Right column shows the same indices but scaled to their respective mean for the overlapping years.

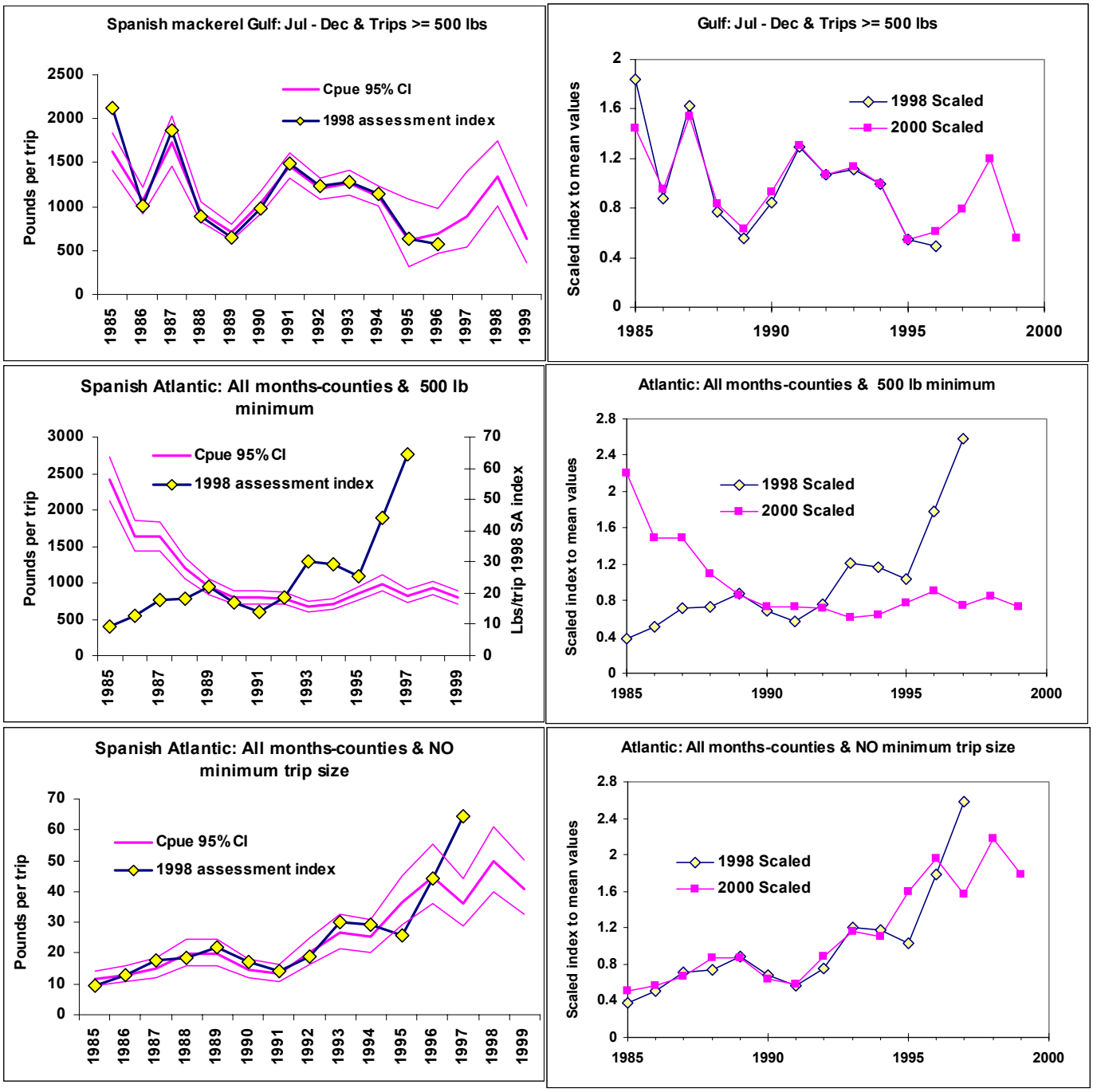

Figure 17 Indices of abundance for Spanish mackerel migratory groups from the FDEP Florida trip ticket program. Left column shows standardized CPUE values and 95% CI, compared to the equivalent indices used in the last assessment. Right column shows the same indices but scaled to their respective mean for the overlapping years.