Assessment Summary Report
Gulf of Mexico Red Snapper
SEDAR 7

Stock Distribution:

- Red snapper are found throughout the Gulf of Mexico, the Caribbean Sea, and from the U.S. Atlantic Coast to northern South America. Major fisheries occur in both U.S. and Mexican waters of the Gulf of Mexico.

- This assessment addresses red snapper in the U.S. Gulf of Mexico. The stock is divided into eastern and western gulf components to allow application of area-specific life history characteristics, catch statistics, and survey indices. This assessment incorporates considerable new information available since the last assessment and includes an extended time series of catch (starting in 1872) derived to improve stock productivity estimates.

Assessment Methods & Data:

- Red snapper in the Gulf of Mexico were assessed with several models, including ASAP, SRA, VPA, and CATCHEM. Within each type of model various configurations were explored. Details of all models are available in the Stock Assessment Report and the Review Panel Consensus Summary.

- The Assessment Workshop chose the CATCHEM model to provide the base assessment results based on its flexibility and better mathematical rigor. The RW accepted this model with some structural modifications that are detailed in the Consensus Summary and summarized here in a subsequent section.

- Data sources include landings, age composition data , fishing effort, and relative abundance indicators from commercial and recreational, directed and bycatch fleets east and west of the Mississippi; multiple fishery-independent relative abundance measures; and recent information on growth and reproduction.

Catch Trends:

- Catch in numbers of fish is dominated by shrimp bycatch which mainly consists of age-0 and age-1 fish (Figure 1). The shrimp fishery annually removes roughly 25-45 million fish, mainly from the western Gulf in recent years. The recreational and commercial fisheries combined take roughly 3-4 million red snapper annually.

- Red snapper taken by the directed commercial and recreational fisheries dominate removals in weight, accounting for about 9 million pounds in recent years. In comparison, the annual weight of the shrimp bycatch returned to the sea was estimated to be roughly two to five million pounds (Figure 2).

Sources of Information:

- Results are summarized in the following bullets. Complete details are available in the SEDAR7 Assessment Report, the SEDAR 7 Review Panel Consensus Summary, and the many SEDAR 7 workshop working papers.

- Complete results of the CATCHEM model configuration preferred by the Review Panel are contained in the Appendix to the Stock Assessment Report.

Status Determination Criteria:

- The Assessment Workshop base case did not include removals of age-0 red snapper. The Review Workshop (RW) recommends including those removals in the assessment.

- The decision to include or exclude age-0 fish is based on assumptions about timing and strength of density dependent effects on survival (in other words, the point at which year-class strength is determined).

- Excluding age-0 removals (whether from landings or discard mortality) implies that, regardless of other factors, cohorts experience such strong compensatory density dependent natural mortality at age-0 that age-0 fishing mortality does not affect abundance at older ages. Including age-0 removals implies that there is no compensation for age-0 fishing mortality and therefore fishing mortality on age-0 affects abundance at older ages.

- Although considerable uncertainty remains regarding the recruitment dynamics of red snapper, the RW does not support assuming that mortality on age-0 fish is irrelevant, and thus does not support excluding age-0 fish from analysis. While some compensation may occur for age-0 fish, it seems unlikely that compensation is so strong that fishing mortality is irrelevant.

- MSY reference points upon which overfishing and overfished criteria and rebuilding plans are based are derived either from spawner-recruitment (S-R) functions or by assuming that MSY is associated with a specific level of spawning per recruit (expressed as a percentage of the unfished level and designed “SPR”).

- The RW concurred with the AW that spawner per recruit (SPR) benchmark levels may be more robust to uncertainties regarding the true underlying stock-recruitment function and selectivity patterns in the fishery. $SPR_{30\%}$, which has already been employed by the Council, is relatively insensitive to benchmarks derived from a stock-recruitment function. The RW points out that SPR benchmarks are consistent with MSY concepts as estimates of both FMSY and BMSY can be inferred from any SPR.

- SPR based reference points are not robust to all aspects of recruitment uncertainty, and they are not entirely robust to size- or age-specific allocation decisions as discussed below.

- The RW did not recommend whether S-R or SPR based reference points should be applied in this case. The RW did agree that a stock-recruitment function with maximum

recruitment based on the recent average recruitment was the most realistic function to use for projections. The RW also agreed that a similar approach should be used for MSY reference points, whether calculated through the S-R or SPR approach.

- The RW points out that both SPR and S-R based approaches require a S-R function to determine MSY and S_{msy}. While the spawning stock at MSY (Smsy) is independent of size or age specific allocation, the biomass at MSY (Bmsy; total recruited biomass associated with MSY) is affected by allocation to some degree, and MSY can be sensitive to it when there are discards.

- Reference values derived through SPR and S-R approaches are dependent on the assumption that the recent average recruitment will continue in the future, with the exception of the value for Fmsy when based on SPR.

- The Council should carefully consider risk to the stock and the relative advantages and disadvantages offered by both MSY and SPR-based approaches when determining the appropriate Maximum Fishing Mortality Threshold (MFMT) and other reference points. Management strategy options and allocation decisions of the Council will influence benchmark values.

- Stock status benchmarks should be tested for robustness to sources of uncertainty within the assessment and to better define the management strategy for red snapper. This would help decrease the range of possible benchmarks for consideration.

Fishing Mortality:

- Fishing mortality is estimated by fleet for both eastern and western stock components.

- Fishing mortality of each fleet in the eastern stock component is below F=0.2 until the mid 1970's . Between 1975 and 1983 the recreational component increases considerably and exceeds F=1.0 in 1983, then remains generally high but variable. Commercial hook and line fishing mortality also increases noticeably after 1980, reaching nearly F=0.4 in 1990, but then returns to pre-1980 levels by the mid-1990s. (Figure 3).

- Bycatch fishing mortality dominates the Western stock component, with estimates increasing from just below F=0.2 in 1950 to nearly F=1 by the mid-1980's and later. Fishing mortality for the recreational fishery begins to increase by 1970, varies around F=0.4 through the 1980's, then declines to around F=0.1. Fishing mortality for the commercial hook and line increases to F=0.2 between 1980 and 1984 where it remains until the mid 1990's when it increases to around F=0.4.

Recruitment and Spawning Stock Level:

- Estimated recruitment for both stock components increases noticeably after 1980 and is generally above the long term average in recent years although spawning stock is estimated to be much lower than it was historically (Figure 4). Possible explanations of such a pattern were

discussed but no single reason emerged as most probable. The Review Panel suggested further research of this issue.

- The panel considers it unlikely that future recruitment can be reasonably predicted from the observed long-term spawner-recruitment relationship and instead recommends basing stock projections on average recruitment estimated between 1984 and 2003.

- Spawning stock depletion in both the east and the west stock components is attributed to the combined effects of direct harvest and bycatch by the shrimp fleet. (Figure 4).

Stock Status:

- Gulf Red Snapper are overfished and overfishing was occurring in 2003 (Table 1, Figure 5). These conclusions are consistent with previous assessments despite changes in stock status criteria and assessment methods over the periods covered by those assessments.

Projections:

- Projections are derived from the area-specific model used to estimate stock status; however, results are also combined across regions to provide gulf-wide values for parameters such as total allowable catch (TAC) and productivity to accommodate the current management system (Table 1).

- Projection results presented are a subset of many possible scenarios considered during the Assessment and Review Workshops. Scenarios presented here were chosen to illustrate the trade-off between bycatch removals and directed harvest and to examine the feasibility of stock recovery within the rebuilding timeframe.

- The Review Panel considers future recruitment the greatest source of uncertainty in projections and recommends exploring several alternative future recruitment assumptions. Projections presented here are based on the base case, which assumes future recruitment will be the same as the average estimated recruitment for 1984-2003. Results of all projection scenarios are summarized in the Consensus Summary and detailed in the Stock Assessment Report Appendix.

- Higher directed fishery yield is feasible in future years if mortality from shrimp fishery bycatch is reduced below current levels (Table 1, Figure 6).

- The Gulf-wide SPR could exceed 30% by 2032 with long-term directed fishery yields ranging from 2-25 million pounds if shrimp fishery bycatch mortality is further reduced (Table 1, Figure 6). Long-term yields of 3 million pounds are feasible if shrimp bycatch mortality allocation is further reduced 40% and directed fishing continues at the $F_{30\%SPR}$ rate ; long-term yields of 6.3 million pounds are feasible if shrimp bycatch mortality allocation is further reduced 50% and directed fishing continues at the $F_{30\%SPR}$ rate, and long-term yields of 25 million pounds are feasible under the equal proportion mortality rate reduction scenario and directed fishing continues at the $F_{30\%SPR}$ rate.

- The Gulf-wide spawning stock could exceed the S_{msy} ($S_{5\%SPR}$) level fishing at $F_{5\%SPR}$ by 2023 with a resulting long-term directed fishery yield thereafter of MSY=11 million pounds under the 'current shrimp' allocation scenario. Gulf wide spawning stock could exceed the S_{msy} level by 2031 with directed fishery yields between 17 and 25 million pounds if shrimp fishery bycatch mortality allocation is further reduced (Table 1, Figure 6). Long-term yields of 17 million pounds are feasible if shrimp bycatch mortality allocation is reduced a further 40% ($S_{msy}=S_{7\%SPR}$) and directed fishing continues at the $F_{7\%SPR}$ rate; long-term yields of 18 million pounds are feasible if shrimp bycatch mortality allocation is reduced a further 50% ($S_{msy}=S_{8\%SPR}$) and directed fishing continues at the $F_{8\%SPR}$ rate, and long-term yields of 25 ($S_{msy}=S_{27\%SPR}$) million pounds are feasible if shrimp and directed fisheries are reduced equally and directed fishing continues at the $F_{27\%SPR}$ rate.

- The previous two statements refer to results combined for both the east and west stock components. However, if red snapper are treated as separate stocks in the eastern and western Gulf of Mexico, all projection scenarios indicate the eastern stock can recover with the allotted time, whereas the western stock may not rebuild in the allotted time frame under some projection scenarios. (see caption of Table 1).

- The outlook for each component differs if red snapper are considered separate stocks in the eastern and western Gulf of Mexico. For the western component, only the equal proportion reduction scenario provides recovery to $SPR_{30\%}$ by 2032, and the stock cannot reach $SPR_{30\%}$ under either the current shrimp or 40% shrimp reduction scenarios. The western component may reach S_{msy} between 2024 and 2032, depending upon which scenario is chosen. The eastern stock component can achieve $SPR_{30\%}$ by 2028 and S_{msy} by 2027 under all scenarios (Table 1).

Table 1. Summary of the status of red snapper in the Gulf of Mexico relative to MSY and $SPR_{30\%}$ criteria conditioned on four bycatch mortality scenarios: (1) directed fishery mortality rates reduced by same proportion, but bycatch mortality rates (shrimp and closed season) remain at current levels, (2) like 1, but shrimp bycatch mortality rates reduced by 40%, (3) like 1, but shrimp bycatch mortality rates reduced by 50%, and (4) mortality rates associated with all fleets (directed and bycatch) reduced by the same proportion. Note that the second scenario (40% reduction) reflects the expectations of an economic forecast, with the predicted reductions modeled to begin and continue after 2007. The third scenario (50% reduction) is shown because SPR values of 30% or higher could not be achieved for the western stock under a 40% reduction. The sections labeled 'East' and 'West' give the results expected when the two stocks will be managed independently. The section labeled 'Gulf' gives the results expected when the stocks are managed as a single unit. An asterisk (*) indicates that a sustainable directed fishery harvest at the $F_{30\%}$ level cannot be achieved. Note that the projections and status criteria assume future recruitment will follow a Beverton-Holt spawner-recruit relationship with virgin recruitment levels equal to the average recruitment estimated for 1984-2003 and steepness = 0.974. The statistic S_0 here represents the spawning potential of the stock under this new spawner-recruit relationship (rather than the historical virgin spawning potential).

		Shrimp fishery bycatch mortality reduction scenario			
Area	Benchmark statistic	Current shrimp	40% shrimp reduction	50% shrimp reduction	Equal proportion reduction
East	Yield at $F_{30\%}$ (mp)	3.1	3.9	4.1	6.4
	$F_{2003}/F_{30\%}$	8.2	6.6	6.3	4.1
	$S_{2003}/S_{30\%}$	0.11	0.11	0.11	0.11
	$S_{2010}/S_{30\%}$	0.33	0.32	0.31	0.37
	year $S/S_{30\%} = 1$	2028	2028	2028	2027
	MSY (mp)	4.6	5.1	5.3	6.4
	F_{2003}/F_{MSY}	2.6	2.6	2.6	3.6
	S_{2003}/S_{MSY}	0.29	0.25	0.25	0.13
	S_{2010}/S_{MSY}	0.60	0.55	0.53	0.41
	year $S/S_{MSY} = 1$	2022	2022	2023	2027
	SPR at F_{MSY}	11%	13%	13%	26%
	S_{2003}/S_0	0.032	0.032	0.032	0.032
West	Yield at $F_{30\%}$ (mp)	*	*	1.2	18.9
	$F_{2003}/F_{30\%}$	*	*	61.9	4.3
	$S_{2003}/S_{30\%}$	*	*	0.04	0.04
	$S_{2010}/S_{30\%}$	*	*	0.15	0.21
	year $S/S_{30\%} = 1$	*	*	>2032	2032
	MSY (mp)	6.8	11.4	12.9	19.0
	F_{2003}/F_{MSY}	2.2	2.1	2.0	3.9
	S_{2003}/S_{MSY}	0.29	0.19	0.17	0.04
	S_{2010}/S_{MSY}	0.64	0.43	0.40	0.22
	year $S/S_{MSY} = 1$	2024	2026	2027	2032
	SPR at F_{MSY}	4%	6%	7%	27%
	S_{2003}/S_0	0.011	0.011	0.011	0.011

Table 1 continued

Area	Benchmark statistic	Shrimp bycatch mortality reduction scenario			
		Current shrimp	40% shrimp reduction	50% shrimp reduction	Equal proportion reduction
Gulf	Yield at $F_{30\%}$ (mp)	*	3.0	6.3	25.3
	$F_{2003}/F_{30\%}$	*	35.7	18.8	4.3
	$S_{2003}/S_{30\%}$	*	0.05	0.05	0.05
	$S_{2010}/S_{30\%}$	*	0.19	0.19	0.24
	year $S/S_{30\%} = 1$	*	2032	2032	2031
	MSY (mp)	11.3	16.5	18.1	25.4
	F_{2003}/F_{MSY}	2.3	2.2	2.2	3.8
	S_{2003}/S_{MSY}	0.29	0.21	0.20	0.06
	S_{2010}/S_{MSY}	0.62	0.46	0.43	0.26
	year $S/S_{MSY} = 1$	2023	2026	2026	2031
	SPR at F_{MSY}	5%	7%	8%	27%
	S_{2003}/S_0	0.015	0.015	0.015	0.015

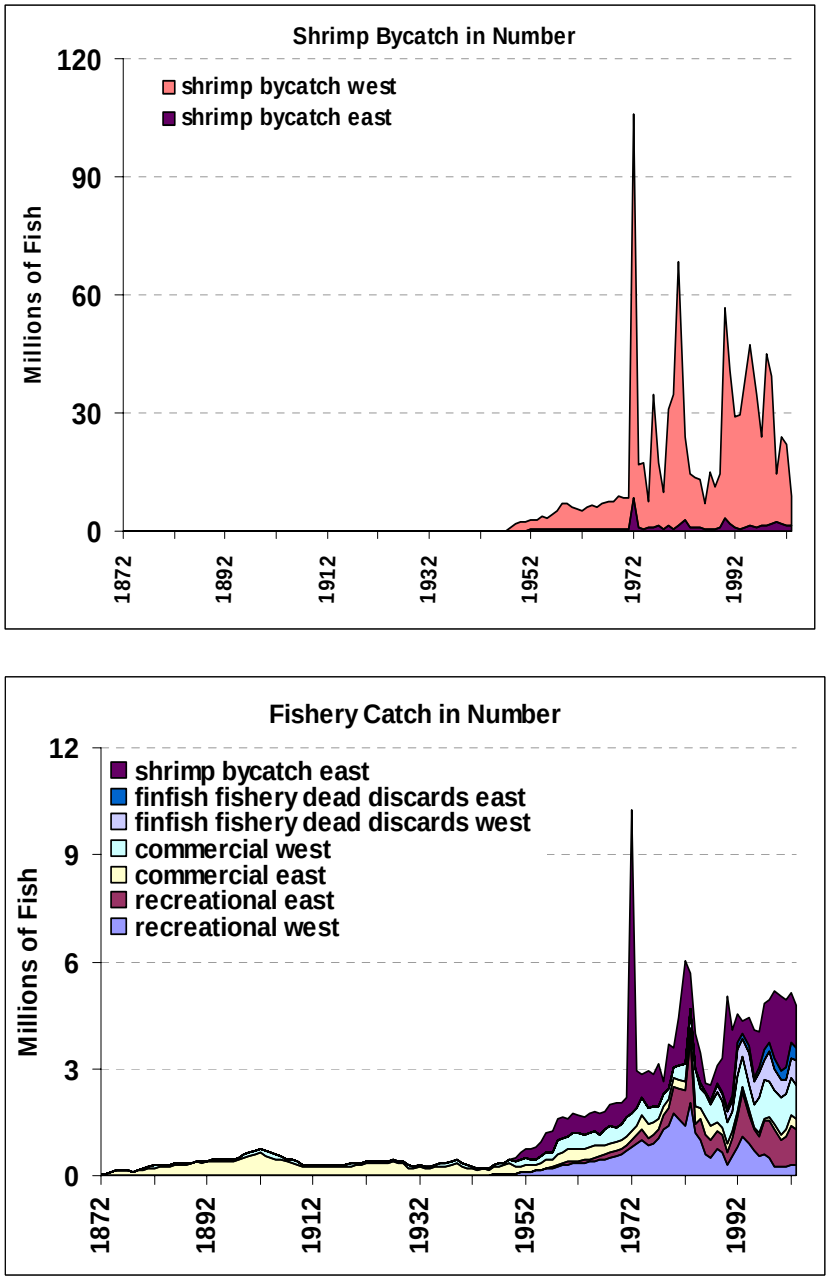

Figure 1. Estimated and calculated catch in number of red snapper from the shrimp fishery (upper panel, east and west) and the eastern shrimp fishery and the east and west finfish fisheries for 1872-2003. Note the differences in scale between the two panels.

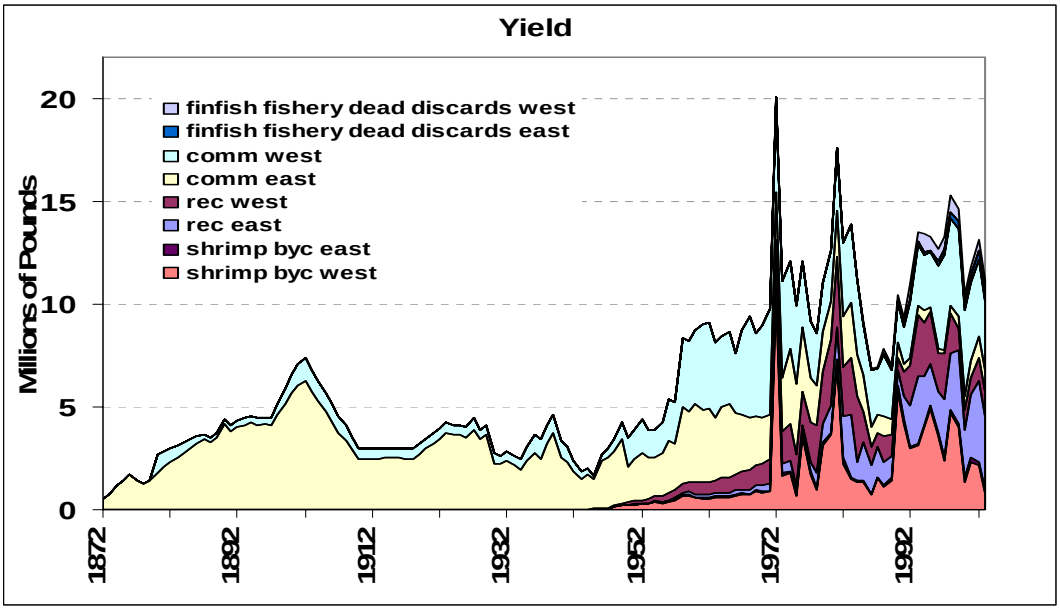

Figure 2. Recorded and calculated weight (pounds) of red snapper landed and discarded from the recreational, commercial, and shrimp fisheries during 1872-2003.

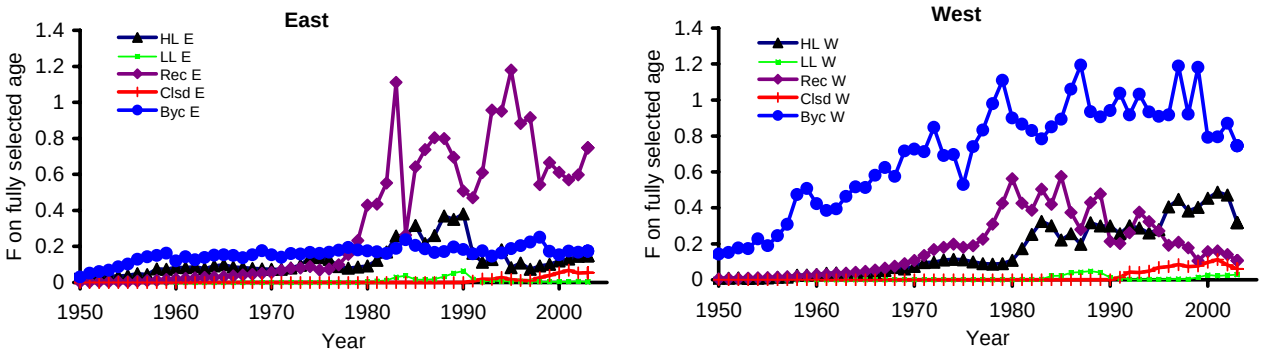

Figure 3. Trends in estimated fishing mortality rates for the most vulnerable age class for each fishing fleet modeled. Fleet designations are: HL handline, LL longline, Rec recreational, Clsd closed season, Byc shrimp bycatch. E designates eastern Gulf fleets and W designates western Gulf fleets.

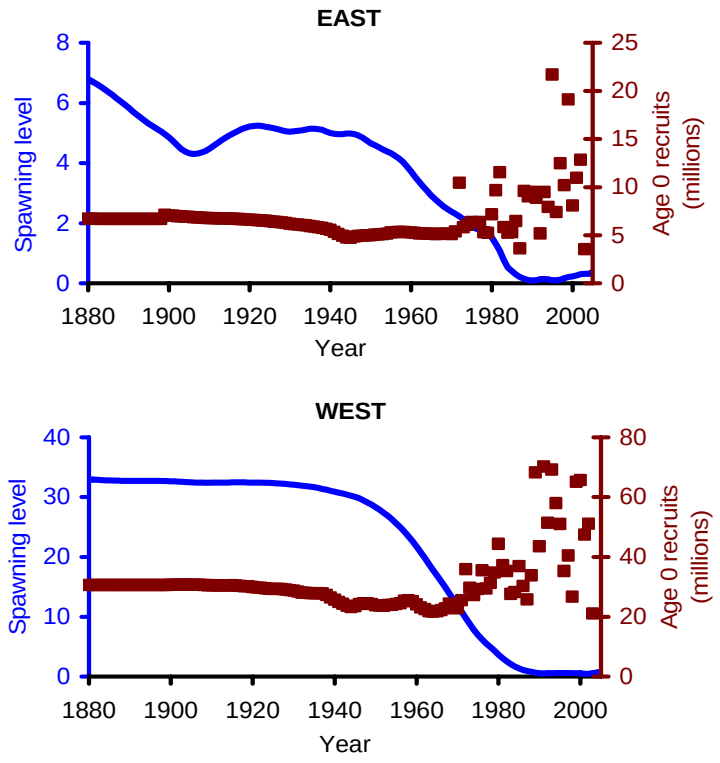

Figure 4. Estimated trends in red snapper spawning level (solid line) and recruitment (squares) for the eastern and western Gulf of Mexico.

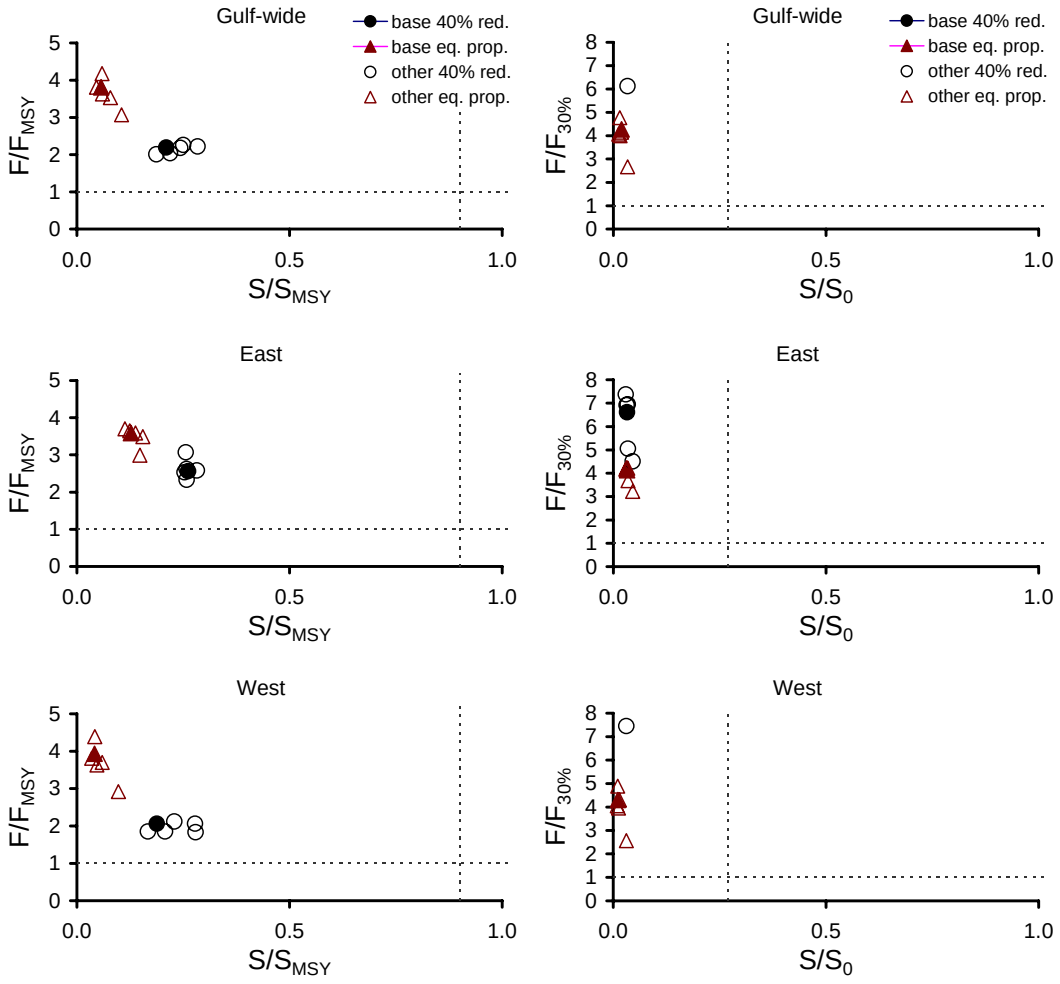

Figure 5. Status determinations for the base case assessment model applications (solid symbols) and for sensitivity analyses (hollow symbols). Left hand plates show results for F_{2003}/F_{MSY} (assuming either a 40% additional reduction in shrimping-induced mortality (circles) or equal proportional reduction in both shrimp and finfish fisheries mortality (triangles)). Right hand plates show $F_{2003}/F_{30\%SPR}$ and associated spawning potential relative to virgin conditions (S_{2003}/S_0) for the same model runs. Note that some model outcomes indicated $F_{30\%SPR}$ could not be sustained unless shrimping-induced mortality was reduced by more than 40% and are therefore not shown. Reference lines represent MSST (vertical) and MFMT (horizontal).

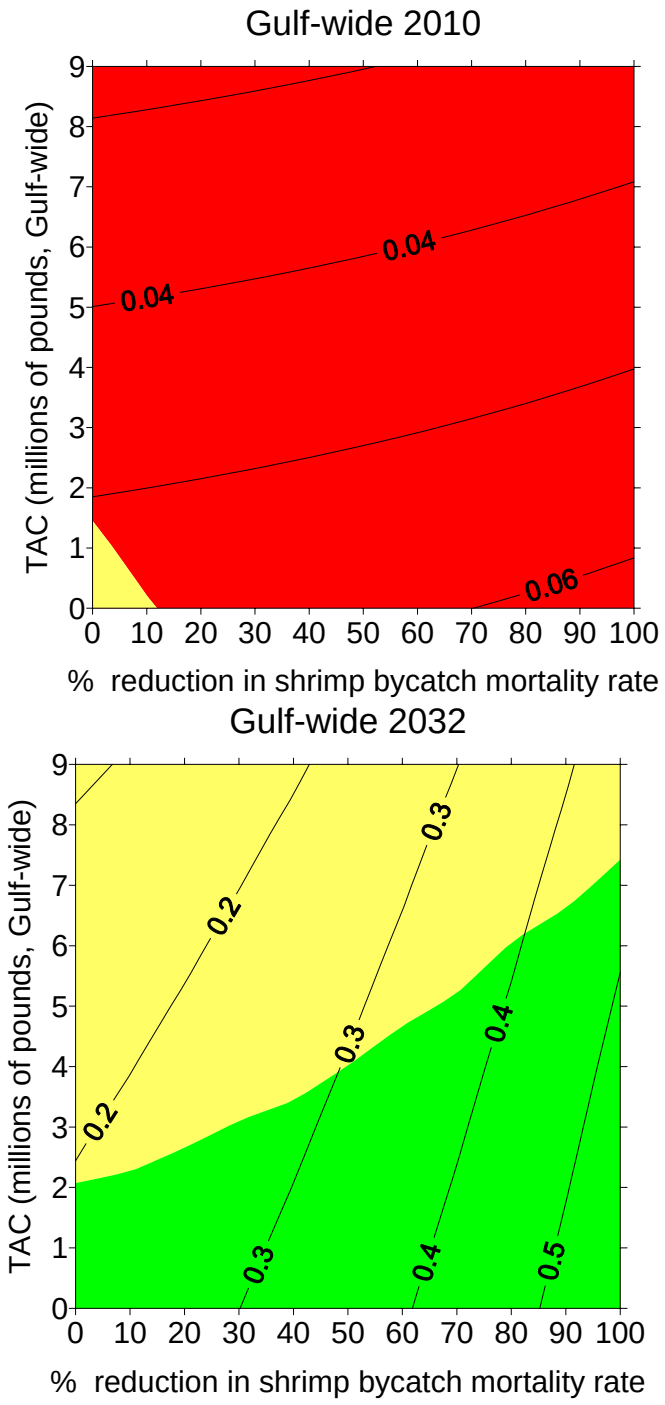

Figure 6. Isopleths of spawning potential in the year 2010 and 2032 relative to virgin levels (S_{2032}/S_0). These isopleths were determined assuming that future recruitments will follow a Beverton-Holt spawner-recruit relationship with virgin recruitment levels equal to the average recruitment estimated for 1984-2003. The horizontal axis refers to the projected shrimp bycatch mortality rate in terms of a *percentage reduction* from current levels and the vertical axis refers to the projected Gulf-wide TAC. The color shades on the graphs represent different levels of spawning potential relative to conditional MSY levels, where MSY is conditioned on the indicated reduction in shrimp effort. Red represents $S_{year}/S_{MSY} < 1$, yellow represents $1 < S_{year}/S_{MSY} < 4$, and green represents $S_{year}/S_{MSY} > 4$.

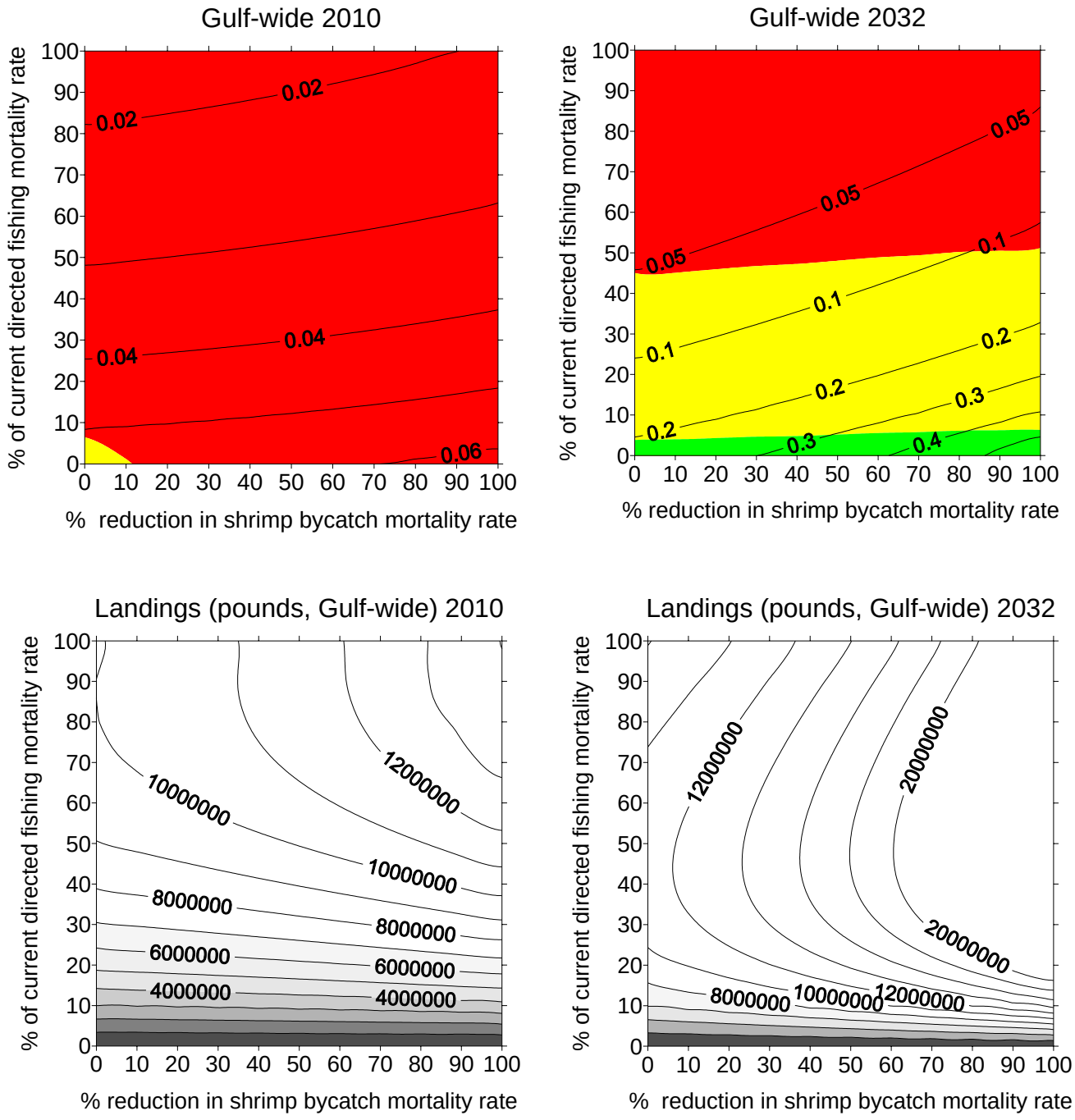

Figure 7. Isopleths of spawning potential relative to virgin levels (S_{2032}/S_0, top panels) and Gulf-wide landings (bottom panels) in the years 2010 and 2032. These isopleths were determined assuming that future recruitments will follow a Beverton-Holt spawner-recruit relationship with virgin recruitment levels equal to the average recruitment estimated for 1984-2003. The horizontal axis refers to the projected shrimp bycatch mortality rate in terms of a *percentage reduction from* current levels. The vertical axis refers to the projected directed fishery mortality rate as a *percentage of* current levels. The color shades on the upper graphs represent different levels of spawning potential relative to conditional MSY levels, where MSY is conditioned on the indicated reduction in shrimp effort. Red represents $S_{year}/S_{MSY} < 1$, yellow represents $1 < S_{year}/S_{MSY} < 4$, and green represents $S_{year}/S_{MSY} > 4$.