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**Discards of Red Snapper Calculated for  
Vessels with Federal Fishing Permits in the US South Atlantic:  
Addendum**

Further investigation of the 2010 delta-lognormal discard calculation revealed that the binomial portion (proportion of trips with red snapper discards) of the model was not fully incorporated into the final discard calculations. The continuity case and bootstrap analyses were unaffected. Discard rates and total discards were recalculated with the binomial portion of the model fully included.

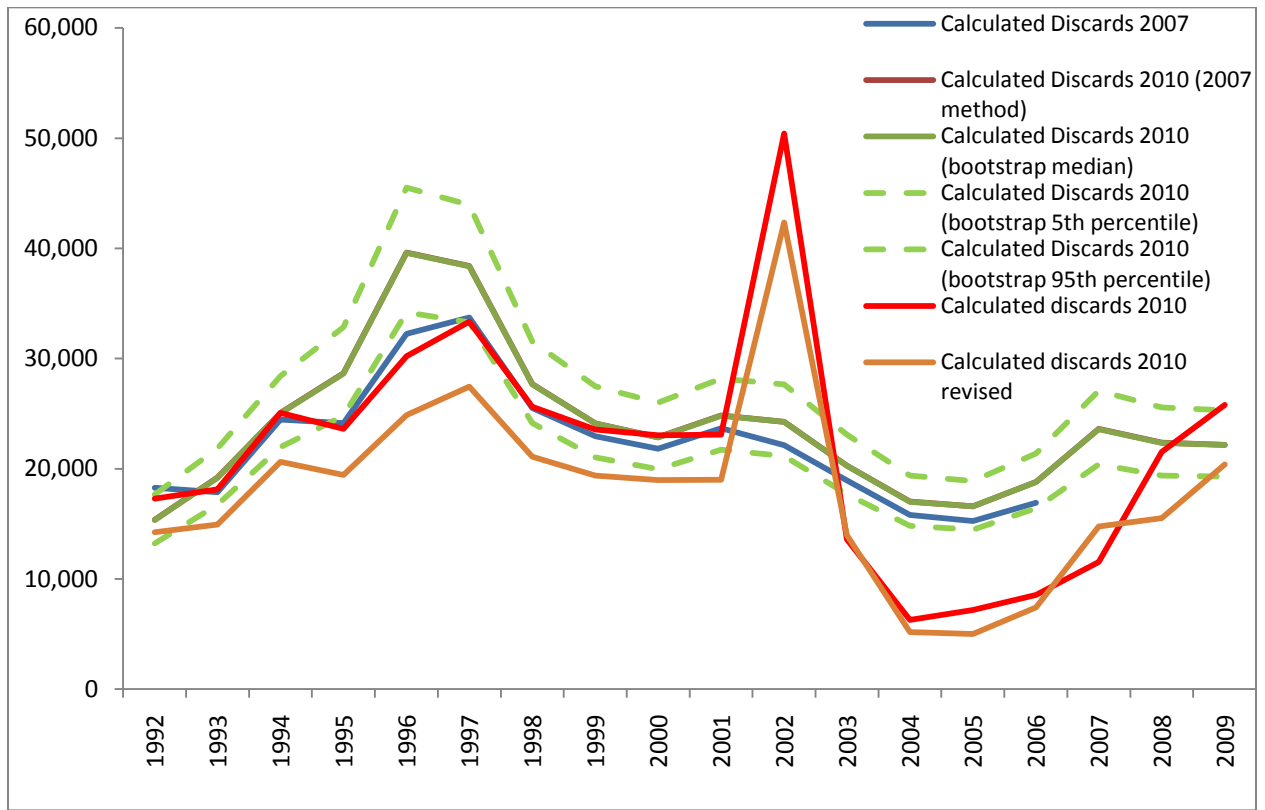
Table A1 includes the yearly total red snapper discards calculated using the 2010 delta-lognormal method described in SEDAR 24-DW01 with the binomial portion of the model integrated into the calculation of discard rate. Also included in Table A1 are the discard rates calculated using the delta-lognormal method, the sample size of the data set used in calculating discard rates, and the variance of the rates. Discard rate and variance for the years 1992-2001 (prior to discard reporting, see SEDAR24-DW01) were calculated as the weighted mean of the 2002-2009 discard rates and variances, respectively.

The revised total discards were lower than the discards calculated using other methods (Figure A1). This result is due to fully incorporating the proportion of trips reporting discarded red snapper in the calculation of discard rates. Trends in total discards remain similar to the earlier 2010 calculated discards (red line in the figure), but of a lower magnitude.

**Table A1.** Commercial vertical line yearly total discards calculated using the 2010 delta-lognormal method, discard rate, variance of discard rate, and sample size of the data used in calculating discard rates. Discards are in number of fish, discard rates are in number of fish per hook hour fished.

Year	Calculated discards 2010 revised	discard rate	observations	variance (discard rate)
1992	14,233	0.014868	N/A	0.0000339097
1993	14,926	0.014868	N/A	0.0000339097
1994	20,638	0.014868	N/A	0.0000339097
1995	19,437	0.014868	N/A	0.0000339097
1996	24,867	0.014868	N/A	0.0000339097
1997	27,458	0.014868	N/A	0.0000339097
1998	21,106	0.014868	N/A	0.0000339097
1999	19,387	0.014868	N/A	0.0000339097
2000	18,975	0.014868	N/A	0.0000339097
2001	19,014	0.014868	N/A	0.0000339097
2002	42,356	0.03507	693	0.0001344356
2003	13,973	0.013506	977	0.0000411723
2004	5,170	0.005623	622	0.0000116804
2005	4,999	0.005914	878	0.0000076249
2006	7,425	0.007839	472	0.0000158225
2007	14,759	0.014624	749	0.0000339821
2008	15,512	0.014783	1,335	0.0000119920
2009	20,402	0.019734	936	0.0000316527

**Figure A1.** Yearly total discards for each calculation method.



## Discards of Red Snapper Calculated for Vessels with Federal Fishing Permits in the US South Atlantic

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### Introduction

In August 2001, the Southeast Fisheries Science Center (SEFSC) initiated a program to collect discard data from commercial fishing vessels landing federally managed species in the Gulf of Mexico and US South Atlantic. A reporting form was developed as a supplement to the mandatory coastal logbook forms for commercial vessels with federal fishing permits (Poffenberger and McCarthy, 2004). Discard data from the SEFSC coastal fisheries logbook program were used to calculate the number of red snapper that were discarded in the US South Atlantic during the period January 1, 2002 through December 31, 2009.

Data collection for the discard logbook program involves, each year, a 20% sample of vessels with Federal fishing permits. To assure that the sample was representative of permitted vessels, the universe of those vessels was stratified by region and gear fished. A random sample, weighted by vessel effort reported the previous year, was selected from each stratum. The US South Atlantic was defined as extending from approximately the North Carolina-Virginia border (37° N) to the ocean-side (south and east) of the Florida Keys-Dry Tortugas. Fishing gear strata included handline, electric reel (bandit rig), trolling, longline, trap, gillnet, and diving. The selected fishers were instructed to complete a supplemental discard form for every fishing trip that they made. Trips with no discards were to be reported as such.

Reported data included the numbers of discards by species, estimated condition of the fish when released, reason for release (due to regulations or unmarketable/unwanted), and the fishing area where the animal was discarded. There were six options for the condition of released fish: all animals dead, majority of animals dead, all animals alive when released, majority of animals alive, fish kept but not sold, and the condition of animals unknown. To calculate species specific discard rates, discard data were matched to the effort data reported to the coastal logbook program.

### Methods

The objective of this analysis was to calculate the numbers of red snapper discarded by vessels that fish commercially for species other than shrimp or other shellfish. Fishing activity for these analyses did not include surface longline vessels that typically fish for swordfish, pelagic sharks, tunas, and other highly migratory species. Discards were calculated using the methods of SEDAR 15 (continuity case). An alternative method using delta-lognormal model generated least squares means of discard rate was also used to calculate total yearly discards.

#### *Continuity case*

Total red snapper discards were calculated following the methods described in McCarthy, 2007. The data set was limited to include only vertical line (handline and electric reel/bandit rig) vessel reports. Discards reported from trips with other gears were insufficient (fewer than 10 trips for any gear) for reliably calculating discards. Data were filtered to remove clearly erroneous records (e.g. fishing more than 24 hours per day, 100 hooks fished per line, etc.). Data were further limited to discard logbook reports from those statistical areas which had reports of red snapper discards.

Analyses completed for SEDAR 15 identified region (defined below) as having a significant effect on discard rate.

Region 1 = 24° N latitude to <30° N latitude  
 Region 3 = 31° N latitude to <33° N latitude

Region 2 = 30° N latitude to <31° N latitude  
 Region 4 = 33° N latitude to <37° N latitude

Region-specific mean red snapper discard rate of all vertical line vessel trips reporting to the discard logbook program, including those that did not have red snapper discards, along with total effort reported to the coastal logbook program were used to calculate total discards:

$$\text{Calculated discards} = \text{Regional mean red snapper discard rate} * \text{total regional effort}$$

Commercial fishing effort data was not reported for the US South Atlantic prior to 1992, therefore, discards were calculated for the years 1992-2009 only. During that period, no regulatory changes likely to affect discard rate were introduced. In 1992, only 20% of Florida vessels were selected to report landings and effort information. To more accurately calculate discards, Florida 1992 effort was expanded by a factor of five.

### ***Bootstrapping***

A bootstrap resampling technique was used to estimate variability in the calculated total discards. For each region, 1,000 data sets were constructed by randomly sampling, with replacement, the original data set used to calculate discard rate. The median, 5<sup>th</sup> percentile, and 95<sup>th</sup> percentile yearly discard rates were calculated from the 1,000 bootstrapped data sets. Total discards were then calculated for each of those rates.

### ***2010 method***

The data set for these analyses included all trips from vessels that reported discards between January 1, 2002 and December 31, 2009. The data were filtered following the same criteria used in the continuity method. The data set was further filtered to remove records from fishers who reported “no discards” of any species for 75% or more of reported trips during years with four or more trips reported by the fisher. This data filter was necessary due to consistent nonreporting of discards by some fishers. Including effort from those fishers would result in discard rates that were erroneously low. Fishers may report “no discards” to the discard logbook program and remain in reporting compliance, however, trips with no discards of any species are rare in the reef fish observer data, suggesting that trips reporting no discards should be much less common than has been found in the self-reported discard logbook data.

The delta lognormal model method (Lo et al. 1992) was used to calculate the yearly least squares means of red snapper discard rate. This method combined separate general linear model (GLM) analyses of the proportion of trips that discarded red snapper and the discard rates of trips that discarded red snapper to construct a single standardized discard rate. Total discards for each year were then calculated using a ratio estimator: yearly least squares means (discard rate)\*reported yearly total effort.

The available data included six factors that were considered for their possible influence on the proportion of vertical line trips that discarded red snapper and on the discard rate of vertical line trips. In order to develop a well balanced sample design, the factors were categorized as:

<b>Factor</b>	<b>Levels</b>	<b>Value</b>
Year	8	2002-2009
Season	4	Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec
Areas fished	2	24°N-30°N, 31°N-35°N
Days at sea	3	1-2, 3-6, 7-12
Crew	2	1-2, 3-6
Number of hook hours fished*	3	1-120, 121-480, >481

\*Number of hook hours fished was included as a factor in the binomial analysis only

Generalized linear model analyses were used to test the above factors for significant effects on discard rate and proportion of trips reporting discards. Parameterization of each model was accomplished using

GENMOD (Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA). A type3 model assuming lognormal error distribution was employed. The linking function selected was “normal”, and the response variable was  $\log(\text{CPUE}) = \log(\text{number of red snapper/hook hour})$ . For each GLM analysis of proportion of trips reporting red snapper discards, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was proportion red snapper discard trips. Only main effects were examined.

A forward stepwise regression procedure was used to determine the set of fixed factors that explained a significant portion of the observed variability. Each potential factor was added to the null model sequentially and the resulting reduction in deviance per degree of freedom was examined. The factor that caused the greatest reduction in deviance per degree of freedom was added to the base model if the factor was significant based upon a Chi-Square test ( $p < 0.05$ ), and the reduction in deviance per degree of freedom was  $\geq 1\%$ . This model then became the base model, and the process was repeated, adding factors individually until no factor met the criteria for incorporation into the final model.

The final delta-lognormal model was fit using a SAS macro, GLIMMIX (Russ Wolfinger, SAS Institute). The yearly least squares means, calculated using GLIMMIX, were included in the year-specific total discards calculation for the years 2002-2009. Discards were calculated for the years 1992-2001 by using the ratio estimator:

$$\text{Mean discard rate (2002-2009)} * \text{year specific total vertical line effort (1992-2001)}$$

Discard rate used to calculate discards during the years 1992-2001 was the mean discard rate of the years 2002-2009 weighted by sample size.

## Results and Discussion

The number of trips that reported discards of red snapper was low, limiting the degree to which the data could be stratified. Red snapper discards were reported from fewer than ten trips per gear by all gears other than vertical line vessels. No red snapper discards were reported from longline trips. The data set for this analysis was limited to trips by vertical line vessels that reported to the discard logbook program between January 1, 2002 and December 31, 2009 in the US South Atlantic. During this period, within the areas reporting red snapper discards, discard forms were submitted for 6,957 trips. Of those trips, discards were reported on 5,390 trips and 1,567 trips reported no animals discarded. Discards of red snapper were reported on 632 trips (9.1%). By way of comparison, there were 276,779 trips reported to the coastal logbook program by vessels issued a Federal permit to fish in the South Atlantic during 2002-2009, of which 27,978 trips landed red snapper (10.1%).

### *Continuity case*

Calculated total discards for each year and region are provided in Table 1 for red snapper discarded from vertical line vessels. Prior to 1993, only 20% of Florida vessels were selected to report to the logbook program. The calculated discards for the region off Florida for 1992 were, therefore, expanded by a factor of five. Calculated discards are summed by year to provide yearly total red snapper vertical line vessel discards in Table 2. Numbers of discards calculated for the SEDAR 15 2007 assessment are also included in Table 2. Discard rates calculated in 2010 differed from the 2007 discard rates for each region due to three additional years of data included in the calculation of regional mean discard rates, resulting in the differences in calculated discards. Minor differences in total effort were also noted between the 2007 and 2010 analyses. An ongoing editing process of the coastal logbook data has resulted in the elimination of duplicate records resulting in slightly lower effort totals for some year and region combinations in the 2010 data set. Late submission of some logbook reports (after SEDAR 15) resulted in slightly greater effort during 2005-2006 in the 2010 data set.

### ***Bootstrapping***

Median, 5<sup>th</sup> percentile, and 95<sup>th</sup> percentile bootstrap estimates of red snapper discards are provided in Table 2. Median discards closely matched the discard totals calculated following SEDAR 15 methods (continuity case). For most years, total discards calculated for SEDAR 15 in 2007 fall within the range of 5<sup>th</sup>-95<sup>th</sup> percentiles of bootstrapped total discards.

### ***2010 method***

The final models for the lognormal on discard rate and binomial on proportion of trips reporting discards were:

$$\text{LOG(Discard rate)} = \text{DAYS} + \text{YEAR} + \text{SEASON} + \text{AREAS FISHED}$$

$$\text{Portion trips reporting discards} = \text{HOOK HOURS FISHED} + \text{YEAR} + \text{CREW}$$

Calculated total discards by year are provided in Table 3 for commercial fishing trips deploying vertical line gear. Total discards calculated using the 2010 method closely matched the discard totals calculated using the 2007 methods and the bootstrap discard estimates for the years 1992-2001. Total discards calculated using the 2010 method were very high in 2002 relative to other years. Examination of the data suggested that a small number of trips with high discard rates may have resulted in the high 2002 calculated discards. No defensible justification could be identified that would allow dropping those records with high discard rates. Low calculated discards for the years 2003-2007 were due to low year specific discard rates. Plots of total discards per year for all methods, including discards calculated for SEDAR 15, are shown in Figure 1.

The release condition of discarded red snapper is reported in Table 4 by region as defined in SEDAR 15. There were more than 14,000 vertical line red snapper discards reported to the coastal logbook discard program. Overall, less than 2% of discarded red snapper were reported as “all dead” or “majority dead” while more than 98% of discards were reported as “all alive” or “majority alive”. Nearly all red snapper discards were reported as “due to regulatory restrictions”. Of those regulatory discards, 43.5% were reported as discarded due to size restrictions and 56% were reported as due to “other regulations”. Those percentages may be misleading, however. Prior to 2008 the discard form provided only two options for the reason for discarding an animal: “regulations” or “market conditions”. Regulatory discards reported before 2008 were categorized as “other regulations” once additional discard categories were introduced in 2008.

The number of trips reporting red snapper discards in the US South Atlantic during the period 2002-2009 was low. Stratification of the available data was limited because of the small sample sizes and likely does not capture much of the variation in numbers of discards within the red snapper commercial fishery. Although clear instances of nonreporting of discards were identified and excluded from the 2010 calculations, other cases of nonreporting and underreporting have not been quantified. The effect this may have had on the discard calculations is unknown. Actual red snapper discards may be higher than the calculated totals presented here, however, discards of red snapper from the commercial fishery appear to be relatively low, particularly when compared to discards in the recreational fishery.

**Literature Cited**

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- McCarthy, K. 2007. Discards of Greater Amberjack and Red Snapper Calculated for Vessels with Federal Fishing Permits in the US South Atlantic. Sustainable Fisheries Division Contribution SFD-2007-025. SEDAR 15-DW01
- Poffenberger, J. and K. McCarthy. 2004. Estimates of red snapper discards by vessels with Federal permits in the Gulf of Mexico. SEDAR 7-DW-22.



**Table 1.** Calculated yearly total discards of red snapper by vertical line vessels for each region following 2007 methods (regions: 1=24° N latitude to <30° N latitude; Region 2 = 30° N latitude to <31° N latitude; Region 3 = 31° N latitude to <33° N latitude; Region 4= 33° N latitude to <37° N latitude).

Year	Region	Mean Discards	Discard Standard Deviation	Total Effort (hook hours)	Calculated Discards (number of fish)
1992*	1	0.00990	0.16526	89,479	886
1992*	2	0.08119	0.57319	85,821	6,968
1992*	3	0.03140	0.19857	195,164	6,129
1992*	4	0.00606	0.06624	228,924	1,387
1993	1	0.00990	0.16526	374,852	3,710
1993	2	0.08119	0.57319	86,342	7,010
1993	3	0.03140	0.19857	204,741	6,429
1993	4	0.00606	0.06624	337,962	2,048
1994	1	0.00990	0.16526	519,938	5,146
1994	2	0.08119	0.57319	94,937	7,708
1994	3	0.03140	0.19857	297,076	9,329
1994	4	0.00606	0.06624	476,132	2,885
1995	1	0.00990	0.16526	418,421	4,141
1995	2	0.08119	0.57319	156,294	12,690
1995	3	0.03140	0.19857	292,482	9,185
1995	4	0.00606	0.06624	440,122	2,667
1996	1	0.00990	0.16526	523,689	5,183
1996	2	0.08119	0.57319	230,232	18,693
1996	3	0.03140	0.19857	401,744	12,616
1996	4	0.00606	0.06624	516,896	3,132
1997	1	0.00990	0.16526	709,474	7,022
1997	2	0.08119	0.57319	206,871	16,797
1997	3	0.03140	0.19857	353,093	11,088
1997	4	0.00606	0.06624	577,396	3,499
1998	1	0.00990	0.16526	522,294	5,169
1998	2	0.08119	0.57319	126,665	10,284
1998	3	0.03140	0.19857	298,594	9,377
1998	4	0.00606	0.06624	472,035	2,860
1999	1	0.00990	0.16526	570,587	5,647
1999	2	0.08119	0.57319	118,819	9,647
1999	3	0.03140	0.19857	201,657	6,333
1999	4	0.00606	0.06624	412,915	2,502
2000	1	0.00990	0.16526	492,559	4,875
2000	2	0.08119	0.57319	100,167	8,133
2000	3	0.03140	0.19857	225,257	7,074
2000	4	0.00606	0.06624	458,300	2,777
2001	1	0.00990	0.16526	418,241	4,139
2001	2	0.08119	0.57319	90,989	7,388
2001	3	0.03140	0.19857	340,826	10,703
2001	4	0.00606	0.06624	428,826	2,598
2002	1	0.00990	0.16526	396,079	3,920
2002	2	0.08119	0.57319	107,209	8,705
2002	3	0.03140	0.19857	291,282	9,147
2002	4	0.00606	0.06624	413,177	2,504
2003	1	0.00990	0.16526	373,061	3,692
2003	2	0.08119	0.57319	89,702	7,283
2003	3	0.03140	0.19857	231,094	7,257
2003	4	0.00606	0.06624	340,721	2,065

\*in 1992 only 20% of vessels in Florida were required to report to the logbook program; calculated discards for areas off Florida (region 1) were expanded by a factor of five.

**Table 1.** continued

Year	Region	Mean Discards	Discard Standard Deviation	Total Effort	Calculated Discards (number of fish)
2004	1	0.00990	0.16526	343,528	3,400
2004	2	0.08119	0.57319	78,631	6,384
2004	3	0.03140	0.19857	166,495	5,228
2004	4	0.00606	0.06624	330,764	2,004
2005	1	0.00990	0.16526	274,083	2,713
2005	2	0.08119	0.57319	70,031	5,686
2005	3	0.03140	0.19857	203,509	6,391
2005	4	0.00606	0.06624	297,585	1,803
2006	1	0.00990	0.16526	278,133	2,753
2006	2	0.08119	0.57319	75,894	6,162
2006	3	0.03140	0.19857	248,212	7,794
2006	4	0.00606	0.06624	344,975	2,090
2007	1	0.00990	0.16526	286,147	2,832
2007	2	0.08119	0.57319	131,274	10,659
2007	3	0.03140	0.19857	257,794	8,095
2007	4	0.00606	0.06624	334,006	2,024
2008	1	0.00990	0.16526	307,236	3,041
2008	2	0.08119	0.57319	113,079	9,181
2008	3	0.03140	0.19857	249,633	7,839
2008	4	0.00606	0.06624	379,397	2,299
2009	1	0.00990	0.16526	364,685	3,609
2009	2	0.08119	0.57319	105,906	8,599
2009	3	0.03140	0.19857	258,807	8,127
2009	4	0.00606	0.06624	304,428	1,845

**Table 2.** Calculated yearly South Atlantic vertical line vessel red snapper discards from SEDAR 15, continuity case, and bootstrapped values of discards. Discards are reported in number of fish.

Year	Calculated Discards 2007	Calculated Discards 2010	Calculated Discards 2010 (bootstrap median)	Calculated Discards 2010 (bootstrap 5 <sup>th</sup> percentile)	Calculated Discards 2010 (bootstrap 95 <sup>th</sup> percentile)
1992*	18,292	15,370	15,354	13,237	17,674
1993	17,860	19,198	19,185	16,745	21,857
1994	24,459	25,068	25,056	21,972	28,428
1995	24,153	28,683	28,657	24,820	32,865
1996	32,254	39,624	39,586	34,192	45,506
1997	33,725	38,405	38,373	33,303	43,935
1998	25,524	27,691	27,672	24,135	31,546
1999	22,959	24,129	24,112	21,030	27,492
2000	21,810	22,859	22,844	19,970	25,991
2001	23,680	24,828	24,817	21,741	28,177
2002	22,133	24,275	24,260	21,155	27,657
2003	18,937	20,297	20,284	17,704	23,109
2004	15,813	17,017	17,005	14,836	19,381
2005	15,272	16,593	16,583	14,478	18,884
2006	16,914	18,800	18,789	16,410	21,389
2007		23,610	23,588	20,394	27,090
2008		22,360	22,342	19,388	25,578
2009		22,180	22,165	19,288	25,315

\*in 1992 only 20% of vessels in Florida were required to report to the logbook program; calculated discards for areas off Florida (region 1) were expanded by a factor of five.

**Table 3.** Calculated yearly South Atlantic vertical line vessel red snapper discards using the 2010 method. Discards are reported in number of fish.

Year	Calculated Discards 2010
1992*	10,826
1993	18,132
1994	25,071
1995	23,612
1996	30,209
1997	33,357
1998	25,640
1999	23,552
2000	23,052
2001	23,098
2002	50,422
2003	13,608
2004	6,276
2005	7,180
2006	8,542
2007	11,533
2008	21,523
2009	25,814

\*in 1992 only 20% of vessels in Florida were required to report to the logbook program; calculated discards for areas off Florida (region 1) were expanded by a factor of five.

**Table 4.** Estimated condition at release of red snapper discards, 2002-2009. Numbers of fish and percent of within each region, in parentheses, are reported by gear and region. Gray cells included data from fewer than three vessels and are confidential. Empty cells had no reports of red snapper discards.

Species	Region	All Dead	Majority Dead	All Alive	Majority Alive	Kept	Unknown	Unreported
Red Snapper (vertical line)	1			1,543 (46.9)	1,750 (52.7)			
	2		45 (0.7)	1,442 (23.2)	4,739 (76.1)			
	3	37 (1.0)	63 (1.7)	1,655 (44.0)	2,005 (53.3)			
	4			853 (88.9)	72 (7.5)			

**Figure 1.** Yearly calculated discards by each method compared.

