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Introduction

In August 2001, the Southeast Fisheries Science Center (SEFSC) initiated a program to collect commercial fishing vessel discard data from Gulf of Mexico fisheries. A reporting form was developed that supplements the existing vessel coastal logbook forms that are currently mandatory for those fisheries (Poffenberger and McCarthy, 2004). Discard data from the SEFSC coastal fisheries discard logbook program were used to calculate the number of red snapper discarded from commercial vertical line (handline and electric/hydraulic reel, aka bandit rig) and bottom longline vessels.

Data collection for the discard logbook program involves, each year, a 20% random sample of vessels with Gulf of Mexico reef fish, king mackerel, Spanish mackerel, dolphin/wahoo, and shark permits selected to report the number of animals discarded by species. To assure that the sample was representative of vessels with those Federal permits fishing in the Gulf of Mexico and South Atlantic, the universe of permitted vessels was stratified by region (Gulf of Mexico and South Atlantic) and gear fished. Fishing gear strata included handline, bandit rig, trolling, longline, fish trap, gillnet, and diving. A random sample (weighted by effort reported by each vessel during the prior year) was selected, without replacement, from each stratum. The selected fishers were instructed to complete a supplemental discard form for each fishing trip. Trips with no discards were reported as such.

Reported data included the numbers of discards by species, the estimated condition of the fish when released, and the fishing area where the animal was discarded. There were seven options for the condition of released fish: all animals are dead, majority of the animals are dead, all animals are alive when released, majority of animals are alive, the fish are kept but not sold, the condition of the animals is unknown, and unreported. To calculate species specific discard rates, discard data were matched to the landings and effort data reported (for the appropriate trip) to the coastal logbook program.

Fishery observer data have been collected from the Gulf of Mexico reef fish fishery since July, 2006. Data collection efforts have been primarily directed towards the vertical line and bottom longline fisheries. Vessels were randomly selected within region (eastern and western Gulf of Mexico) and season (Jan-Mar, Apr-Jun, etc.) strata. Sampling within each region/season stratum was apportioned by the fishing effort (days at sea) reported within each stratum for the previous year. Strata with the highest effort received greater observer coverage (more observer days at sea) than did those strata with lower reported effort.

The observer data was more detailed than the self-reported fishing effort and landings data included in the coastal logbook data set. For example, total catch was recorded for each set; where set was defined as fishing at a specific location; only landings from the entire trip were available in the coastal logbook data. Detailed gear information; including hook size, design (circle or J-hook), number of hooks per line (by reel on vertical line vessels), length of main line, length of gangions, and changes in the number of hooks fished during a set; were also recorded. Exact fishing location (degrees, minutes, seconds of latitude and longitude), depth, bottom type (if known), and species targeted were also recorded.

Observer coverage relative to total fishing effort measured in days at sea has been between 1.1 and 1.7 percent during the period 2006-2009. During 2010 and 2011 observer vertical line coverage was 1.4 and 2.6 percent, respectively. Longline observer coverage was higher, 12.9 and 19.5 percent, during 2010 and 2011.

Methods

Self-reported data

The data set for calculating commercial vessel red snapper discards included all trips from vessels that reported discards to the coastal discard logbook program between January 1, 2002 and December 31, 2011 in the Gulf of Mexico. Total discards from vertical line (handline and electric reel) and longline gear vessels were calculated separately. The available data for other gears were too few for discards to be calculated. Sample sizes (number of trips) reporting discards of red snapper by region (east and west) are provided in Tables 1A-B for vertical line and longline vessels. Total numbers of coastal logbook trips with reported red snapper landings are provided by gear and region in Table 1E.

Available data were filtered to remove records with logical inconsistencies (e.g., reported fishing more than 24 hours), records missing effort (vertical line and trolling gear: missing number of lines fished, hooks per line, or hours fished; gillnet: missing length or depth of net or hours fished). Data reported from trips with discards or fishing effort in both the eastern and western Gulf of Mexico were excluded from the analyses because discard rates and fishing effort cannot be reliably apportioned within single trips. Coastal logbook data (used to calculate total effort) were additionally filtered to remove likely data outliers. Those data that exceeded the 99.5 percentile of the population for any variable used to calculate effort (e.g., number of lines, hooks per line, length of gillnet) were excluded.

For each gear, separate calculations were made for red snapper open and closed seasons (prior to 2007) and for the eastern and western Gulf of Mexico, divided at the Mississippi River delta. Methods for calculating total discards followed those used in SEDAR7 (Poffenberger and McCarthy, 2004) and the red snapper assessment update in 2009. Eight factors were examined with GLM analyses for their possible influences on the red snapper discard rate. Once the significant main effects were identified the data were stratified by those factors and a mean discard rate (vertical line discards per hook hour fished; longline discards per hook fished) was calculated for each stratum. For the years 2007-2011, the amount of red snapper allocation available to a vessel was also used to define strata. The mean discard rate calculations included all discard trips within each stratum, i.e. trips with no red snapper discards reported were included in the discard rate calculations to produce a mean nominal discard rate. Total effort (vertical line hook hours and longline hooks fished) was calculated from the coastal logbook data set for each stratum. Total discards for each stratum were then calculated as: stratum mean discard rate*stratum total effort.

For the years prior to 2002, discards were calculated using the mean discard rate per stratum from the years 2002-2006 applied to the yearly stratum-specific effort reported during the years 1990-2001. During the years 1990-1992 in Florida, only 20% of commercial fishing vessels were selected to report fishing effort to the coastal logbook program. Florida fishing effort was expanded by a factor of five to calculate discards for the years 1990-1992. All other states reported total fishing effort in federal waters, therefore, no adjustment of reported effort was needed for discard calculation.

Adjustment for discard under reporting

Commercial discards may be under reported. A 20 percent sample of fishers was required to report to the discard logbook program in order to renew their federal fishing permits. Fishers remain in reporting compliance by returning discard logbooks with reports of "no discards". The percentage of discard reports from vertical line vessels returned with "no discards" has increased from 42 to 73 percent in southern Florida (McCarthy, 2011). Commercial vertical line trips in southern Florida that had fishery observers onboard, however, report only 10 percent of trips had no discards. Sample size of the observer trips in southern Florida was low (30 trips in areas 1-4, no observer coverage in the southern Florida portion of the South Atlantic), however the large discrepancy between observer reports of "no discards" and self-reported "no discards" suggests that under reporting may be occurring. To reduce the likelihood of using discard rates that were erroneously low, the data set was filtered to remove records

"no discards" reported. Discards were recalculated using that filtered data set. Data were stratified as defined above for the self-reported data, discard rates per stratum calculated, and stratum-specific total discards calculated.

Observer data discards

Fishery observer data were available for the period July, 2006 to December, 2011. Management through Individual Fishing Quotas (IFQ) began in January, 2007. The management change from a "derby" fishery to an IFQ fishery has resulted, according to fishers, in less red snapper directed effort, and may have affected discard rates. Given that change in fisher behavior, discard rates observed under IFQ management are not appropriate for use in calculating discards during the period 1990-2006. The limited available observer data for 2006 (prior to IFQs) were likely insufficient to be representative of pre-IFQ discard rates. Applying the 2006 observer reported discard rates in calculations of pre-2006 discards was not done. All discard calculations for the years prior to 2006 were completed using self-reported data.

Sample sizes (trips) of observer data with reported red snapper discards are provided in Tables 1C-D. Funding cuts reduced the level of sampling possible in 2008. In other years, research priorities lead to reallocation of observer resources, resulting in reduced observer coverage. During the most recent years, increased funding resulted in increased observer data collection.

Discard calculation methods followed those used during the 2009 assessment update. Due to the limited observer data, only two factors were examined for their possible affects on discard rates. General linear models were used to examine effects of season and region on discard rate. For longline vessels, two seasons (January-June and July-December) and two regions (statistical areas 2-4 and 5-8) were considered. For vertical line vessels, four quarters (January-March, April-June, etc.) and five regions (1-5, 6, 7, 8-9, and 10-11) were considered. Differences in discard rates were identified for the longline data between seasons. Vertical line discard rates differed among regions. Discard rates by strata (season for longline; region for vertical line) were applied to the total effort (longline hooks fished; vertical line total hook hours) reported to the coastal logbook program from the appropriate strata.

Results and Discussion

Yearly red snapper discards calculated using self-reported discard rates, uncorrected for possible under reporting are provided in Tables 2 (vertical line) and 3 (bottom longline). Discards totals were in close agreement to those calculated for the 2009 red snapper assessment update. Minor differences were likely due to removal of duplicate records and correction of erroneous records in the data base. In addition, where discard rates were calculated as a mean rate across multiple years; those rates changed with additional years of data. Such changes in mean discard rate affected calculations of discards during 1990-2001. Very low calculated discards for "IFQ west" were driven by decreasing reported effort over time and low discard rates reported, especially during 2009-11.

The vertical line fishery accounted for the majority of red snapper discards, by one to two orders of magnitude per year/region/season stratum, compared to the bottom longline fishery. The disparity in discards among gears was also found during the years of management through IFQs. Yearly discards calculated using observer reported discard rates are shown in Table 4. Those observer discard rate based calculations resulted in higher total vertical line discards than did the calculations using self-reported discard rates; often four to five times higher. The 2007-2008 eastern Gulf longline self-reported discards were higher than the observer reported discards, perhaps due to low observer coverage. Calculated discards of eastern Gulf longline vessels were similar using observer and self-reported data. Observer coverage was higher during those years. Western Gulf longline calculated discards were low using discard rates from either data set. No observer data were available from the western Gulf longline fishery during 2006-2007.

Total discards calculated using data filtered to remove records reporting "no discards" are included in Tables 5 (vertical line) and 6 (bottom longline). Also included are total discards calculated with "no discards" records included. Not surprisingly, with "no discards" records excluded (i.e., removal of some zero discard records) total calculated discards were usually greater than those calculated prior to filtering the data set. In two cases, calculated discards were unchanged following removal of "no discards" records (e.g., west closed season vertical line). In the

western Gulf of Mexico, differences in total discards within strata following exclusion of "no discards" records were relatively small; less than 10 percent in all but two cases and often less than five percent. In the eastern Gulf of Mexico, vertical line calculated discards were usually more than 10 percent higher with the exclusion of "no discards" records. In four strata, calculated discards were more than 15 percent greater after data filtering.

The bottom longline fishery reported fewer red snapper discards than the vertical line fishery. Exclusion of "no discards" records resulted in proportionally much higher calculated red snapper discards in the bottom longline fishery. In some cases (e.g., IFQ west), discards calculated with "no discards" records excluded were two orders of magnitude greater than discards calculated with "no discards". Total discards calculated for the longline fishery were much lower than vertical line fishery discards, however, even with "no discards" records excluded from the calculations.

Literature Cited

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Table 1. Number of trips reporting red snapper to the commercial discard logbook program, reef fish observer program, and the coastal logbook program.

A. Number of commercial vertical line self-reported logbook trips with red snapper discards reported.

Year	East	West
2002	342	205
2003	357	330
2004	367	312
2005	364	329
2006	337	219
2007	375	105
2008	929	170
2009	495	70
2010	556	115
2011	563	71

B. Number of commercial longline self-reported logbook trips with red snapper discards reported.

Year	East	West
2002	27	14
2003	27	
2004	36	28
2005	16	18
2006	15	
2007	37	4
2008	37	
2009	48	
2010	33	6
2011	95	

C. Number of commercial vertical line observer trips with red snapper discards reported.

Year	East	West
2006	21	11
2007	65	16
2008	23	15
2009	26	3
2010	32	3
2011	56	11

D. Number of commercial longline observer trips with red snapper discards reported. No longline trips in the western Gulf of Mexico had red snapper discards reported by observers during 2006 or 2007.

Year	East	West
2006	9	
2007	8	
2008	2	3
2009	22	
2010	32	6
2011	64	

E. Number of coastal logbook self-reported trips with red snapper landings reported.

Year	Vertical line east	Longline east	Vertical line west	Longline west
1990	567	144	204	31
1991	1,119	185	728	71
1992	500	38	901	22
1993	1,064	159	1,991	38
1994	1,185	107	1,587	27
1995	722	46	1,651	37
1996	839	106	2,571	25
1997	798	110	2,773	29
1998	1,090	93	2,831	20
1999	1,338	124	2,448	61
2000	1,864	93	2,445	93
2001	1,842	94	2,427	81
2002	2,103	109	2,419	82
2003	2,133	120	2,400	102
2004	2,285	138	2,559	223
2005	2,073	166	2,188	139
2006	2,059	163	2,406	135
2007	1,522	76	906	44
2008	1,494	92	616	34
2009	1,692	37	527	41
2010	2,144	168	504	23
2011	2,478	205	503	10

Table 2. Yearly commercial vertical line vessel red snapper discards calculated from self reported catch and effort data. Discards are reported in number of fish. Minor differences between discard totals provided below and the 2009 update assessment are likely due to removal of duplicate records and data base corrections since that assessment or late reporting to the coastal logbook program. Very low discards for IFQ west were driven by decreasing reported effort over time and low discard rates reported, especially during 2009-11.

Year	East open season	East closed season	West open season	West closed season
1990	133,336		513,291	
1991	222,762	97,969	783,451	94,438
1992	56,712	272,327	261,768	162,617
1993	46,291	194,610	298,582	74,272
1994	45,560	300,107	303,044	48,373
1995	35,084	292,159	300,971	46,224
1996	70,458	406,998	759,844	49,649
1997	63,919	309,097	642,199	75,036
1998	82,149	323,831	753,786	75,451
1999	92,221	396,469	713,691	59,700
2000	127,549	213,319	627,137	74,537
2001	115,499	204,549	725,673	58,987
2002	171,371	139,016	729,981	163,220
2003	152,134	336,173	644,390	37,335
2004	70,463	165,902	607,907	42,021
2005	126,063	116,561	831,849	30,515
2006	100,183	82,239	424,546	17,504
	IFQ East		**IFQ West**	
2007	222,957		98,321	
2008	280,914		86,129	
2009	434,561		10,825	
2010	204,267		6,145	
2011	220,596		13,269	

Table 3. Yearly commercial longline vessel red snapper discards calculated from self reported catch and effort data. Discards are reported in number of fish. Minor differences between totals provided below and the 2009 update assessment are likely due to removal of duplicate records and data base corrections since that assessment or late reporting to the coastal logbook program. IFQ totals vary from 2009 update because discard rate was calculated as the average across all years; with additional years included in the average, the eastern rate was higher (~2x) and the western rate was lower (~1/2).

Year	East open season	East closed season	West open season	West closed season
1990	6,317		711	
1991	7,651	8,712	2,140	90
1992	1,848	15,607	336	160
1993	1,268	19,452	709	307
1994	1,497	22,876	1,042	415
1995	971	19,225	1,387	773
1996	1,454	20,012	1,136	564
1997	1,398	25,284	671	349
1998	1,097	23,012	691	424
1999	1,453	22,324	2,325	794
2000	1,289	17,523	1,760	590
2001	1,180	16,929	1,036	405
2002	1,408	8,643	1,577	540
2003	1,307	4,798	3,401	656
2004	1,690	27,990	5,174	569
2005	1,424	9,676	4,518	476
2006	1,851	5,889	4,058	334
	IFQ East		**IFQ West**	
2007	72,116		355	
2008	70,187		302	
2009	37,792		390	
2010	20,689		217	
2011	29,525		202	

Table 4. Yearly commercial vessel red snapper discards calculated from observer reported catch and effort data. Discards are reported in number of fish. Minor differences between totals provided below and the 2009 update assessment are likely due to removal of duplicate records and data base corrections since that assessment or late reporting to the coastal logbook program. For example, low west vertical line total discards in 2008 compared to the 2009 update calculated totals for 2008 were due to differences in the observed discard rates, 0.1741 (N=1,219) vs. 0.2186 (N=1,225).

Year	East vertical line	East longline	East longline*	West vertical line	West longline
2006	440,784	9,222		463,912	
2007	613,590	34,048		384,168	
2008	353,038	4,268	12,644	424,410	527
2009	856,207	32,298		32,501**	754
2010	497,910	14,187		469,714	483
2011	265,467	20,817		201,740	450

*****includes nonrandomly selected eastern Gulf longline trips during 2008.

**low west vertical line total discards in 2009 due to very low observed discard rate (0.01 vs 0.1-0.2 fish/hook hour observed during other years). Few sets were observed during 2009. The highest discard rate, 0.22 red snapper/hook hour, also occurred in a year (2010) with few sets observed.

Table 5. Yearly commercial vertical line vessel red snapper discards calculated from self reported catch and effort data using SEDAR7 and 2009 update methods (continuity) compared to discards calculated with "no discards" records excluded.

Year	East open season		East closed season		West open season		West closed season	
	continuity	"no discards" excluded	continuity	"no discards" excluded	continuity	"no discards" excluded	continuity	"no discards" excluded
1990	133,336	160,529			513,291	514,832		
1991	222,762	283,019	97,969	110,132	783,451	789,015	94,438	94,552
1992	56,712	70,130	272,327	306,349	261,768	268,014	162,617	163,905
1993	46,291	51,412	194,610	222,746	298,582	316,531	74,272	77,583
1994	45,560	51,153	300,107	341,137	303,044	314,558	48,373	51,525
1995	35,084	38,470	292,159	338,125	300,971	313,774	46,224	50,618
1996	70,458	75,826	406,998	468,420	759,844	780,752	49,649	53,995
1997	63,919	70,864	309,097	357,005	642,199	665,234	75,036	80,294
1998	82,149	95,073	323,831	369,511	753,786	780,944	75,451	80,691
1999	92,221	104,236	396,469	451,302	713,691	735,395	59,700	65,489
2000	127,549	142,410	213,319	245,565	627,137	650,846	74,537	81,421
2001	115,499	131,998	204,549	234,182	725,673	749,238	58,987	64,550
2002	171,371	178,383	139,016	144,089	729,981	729,981	163,220	163,848
2003	152,134	168,982	336,173	461,119	644,390	678,232	37,335	42,437
2004	70,463	77,097	165,902	195,082	607,907	615,041	42,021	44,474
2005	126,063	135,848	116,561	126,734	831,849	848,414	30,515	31,865
2006	100,183	106,061	82,239	94,408	424,546	434,172	17,504	17,504

	IFQ East		IFQ West	
	continuity	"no discards" excluded	continuity	"no discards" excluded
2007	222,957	249,901	98,321	105,229
2008	280,914	321,773	86,129	94,040
2009	434,561	491,041	10,825	11,047
2010	204,267	249,282	6,145	7,228
2011	220,596	251,164	13,269	13,713

Table 6. Yearly commercial longline vessel red snapper discards calculated from self reported catch and effort data using SEDAR7 and 2009 update methods (continuity) compared to discards calculated with "no discards" records excluded. Discards are reported in number of fish.

Year	East open season		East closed season		West open season		West closed season	
	continuity	"no discards" excluded	continuity	"no discards" excluded	continuity	"no discards" excluded	continuity	"no discards" excluded
1990	6,317	9,785			711	830		
1991	7,651	11,759	8,712	8,996	2,140	2,521	90	133
1992	1,848	2,891	15,607	16,170	336	400	160	235
1993	1,268	1,955	19,452	44,553	709	851	307	452
1994	1,497	2,330	22,876	54,211	1,042	1,248	415	611
1995	971	1,522	19,225	35,527	1,387	1,635	773	1,139
1996	1,454	2,206	20,012	34,621	1,136	1,398	564	832
1997	1,398	2,177	25,284	48,846	671	818	349	515
1998	1,097	1,701	23,012	49,086	691	834	424	625
1999	1,453	2,283	22,324	48,548	2,325	2,979	794	1,170
2000	1,289	2,019	17,523	29,246	1,760	2,137	590	869
2001	1,180	1,833	16,929	27,449	1,036	1,261	405	596
2002	1,408	2,214	8,643	9,026	1,577	1,889	540	795
2003	1,307	2,054	4,798	5,638	3,401	4,289	656	966
2004	1,690	2,658	27,990	28,535	5,174	6,574	569	839
2005	1,424	2,239	9,676	17,841	4,518	5,853	476	701
2006	1,851	2,911	5,889	6,427	4,058	5,174	334	492

	IFQ East		IFQ West	
	continuity	"no discards" excluded	continuity	"no discards" excluded
2007	72,116	100,630	355	10,196
2008	70,187	97,939	302	9,924
2009	37,792	52,734	390	5,343
2010	20,689	28,869	217	2,925
2011	29,525	41,200	202	4,175