Calculated discards of black sea bass and tilefish from commercial fishing vessels in the US South Atlantic

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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 and South Atlantic 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). As part of the data provided for the Southeast Data Assessment and Review (SEDAR) Data Workshop for South Atlantic black sea bass and tilefish, discard data from the SEFSC coastal fisheries logbook program were used to calculate the number of discards of those species from commercial vessels.

Data collection for the discard logbook program involves, each year, a 20% random sample of vessels with South Atlantic snapper-grouper, king mackerel, Spanish mackerel 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 South Atlantic, the universe of permitted vessels was stratified by gear fished. Fishing gear strata included handline, electric reel (bandit rig), trolling, longline, fish trap, gillnet, and diving. A random sample was selected, without replacement, from each stratum. The selected fishers were instructed to complete a supplemental discard form for every fishing trip that they made. Trips with no discards were 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 are six 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, and the condition of the animals is unknown. 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.

Methods

The objective of these analyses was to calculate the numbers of black sea bass and tilefish discarded by commercial vessels that fished for species other than shrimp or other shellfish. The data set included all commercial fishing trips from federally permitted vessels that reported discards between January 1, 2002 and December 31, 2010, in the US South Atlantic. Fishing activity for the black sea bass analyses included only vertical line gear (handlines, electric and hydraulic reels) and fish traps. Reports of black sea bass discards from vessels fishing other gears included fewer than 20 trips per gear (usually fewer than 10 trips) for the period 2002-2010. The available data for those gears were too few for discards to be calculated. Black sea bass landings were prohibited during portions of 2009 and 2010. Discard rates for open and closed seasons were calculated separately. Longline discard data were examined to determine their utility in calculating total tilefish discards.

Black sea bass discard analyses

Open season discards

Discard rate was defined for vertical line gear as number of black sea bass discarded per hook hour fished. Fish trap discard rate was defined as number of black sea bass discarded per trap fished. Fishing effort data available for fish traps included number of traps fished, number of hauls, and trap soak time. Changes in logbook reporting forms and apparent confusion regarding how fishing effort was to be reported have resulted in inconsistency within the data set. Number of hauls and trap soak time cannot be reliably included in calculations of fishing effort of fish traps, therefore number of traps fished was used as the effort measure for fish traps.

Six factors were considered as possible influences on black sea bass discard rate. Specific factors examined differed between fishing gears. In order to develop a well balanced sample design it was necessary to define categories within some of the factors examined:

Vertical line

Factor	Levels	Value
Year	9	2002-2010
Subregion	4	Statistical areas 2600-2680, 2700-2780, 2800-3081, 3100-3576 (Fig. 1)
Days at sea	2	1, 2+
Quarter	4	Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec
Crew	3	1, 2, 3+ crew members
Hook hours fished[1]	n/a	continuous

[1] Hook hours fished was examined in the vertical line binomial GLM.

Fish Trap

Factor	Levels	Value
Year	9	2002-2010
Subregion	3	Statistical areas 2800-3280, 3300-3379, 3400-3576 (Fig. 1)
Days at sea	2	1, 2+
Quarter	4	1=Jan-Mar, 2=Apr-Jun, 3=Jul-Sep, 4=Oct-Dec
Traps fished	3	1-25, 26-49, 50+
Vessel id	53	Each vessel treated as a separate categorical variable

The number of traps fished and vessel identification number were included as factors in the fish trap models because various fishers may have interpreted the quantity "traps fished" differently. The assumption was made that individual fishers reported the number of traps fished consistently, although the exact meaning (i.e., what quantity was reported) of "traps fished" may have differed among fishers. Number of traps fished and vessel identification number were included as factors as a means of standardizing for differences in how the quantity "traps fished" was reported by fisher.

A delta-lognormal modeling technique (Lo et al. 1992) was used to calculate discard rates for each gear. This method combines separate general linear model (GLM) analyses of the proportion of trips that discarded black sea bass and the discard rates on trips reporting black sea bass discards to determine a single standardized discard rate. Parameterization of each model was accomplished using a GLM analysis (GENMOD; Version 8.02 of the SAS System for Windows © 2000. SAS Institute Inc., Cary, NC, USA).

For each GLM analysis of the proportion of trips with discards, a type-3 model was fit, a binomial error distribution was assumed, and the logit link was selected. The response variable was the proportion of trips with black sea bass discards. During the analysis of discard rates on trips with discards, a type-3 model assuming lognormal error distribution was examined. The linking function selected was "normal", and the response variable was log(discards per unit effort, DPUE). The response variable of vertical line data was calculated as: log(DPUE)=ln(pounds of black sea bass/hook hour fished); for traps the response variable was: log(DPUE)=ln(pounds of black sea bass/trap fished) . All 2-way interactions among significant main effects were examined. Higher order interaction terms were not examined.

Final models for the delta-lognormal analysis were constructed using a forward stepwise regression procedure to determine the set of fixed factors and interaction terms that explained a significant portion of the observed variability in discard rate. 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 and interactions individually until no factor or interaction met the criteria for incorporation into the final model.

Once a set of fixed factors was identified, the influence of the YEAR*FACTOR interactions were examined. YEAR*FACTOR interaction terms were included in the model as random effects. Selection of the final mixed model was based on the Akaike's Information Criterion (AIC), Schwarz's Bayesian Criterion (BIC), and a chi-square test of the difference between the –2 log likelihood statistics between successive model formulations (Littell et al. 1996).

The final delta-lognormal models, fit using the SAS macro GLIMMIX (Russ Wolfinger, SAS Institute), were used to calculate discard rate (provided as least squares means from the GLM) for the years 2002-2010. Discard rate for the period 1993-2001 (prior to discard reporting) was assumed to be the mean discard rate over the years 2002-2010, weighted by sample size. Calculated discard rates were used along with the appropriate yearly total effort (fish trap or vertical line) reported to the coastal logbook program as ratio estimators of yearly total discards. Discards were reported in numbers of black sea bass.

Closed season discards

Data reported from the black sea bass closed seasons had sample sizes too small for delta-lognormal analyses of the discard rates. Nominal discard rates for vertical line and trap vessels were calculated using the limited closed season data. As with the open season calculations, closed season discard rates were used along with the effort reported by vertical line and trap vessels during the closed seasons to calculate total discards.

Results and Discussion

Tilefish

Data were insufficient to calculate tilefish discards. Fewer than 10 trips reported tilefish discards during the period 2002-2010. That total included all commercial fishing gears. Additional characteristics of the commercial fishery suggest that few tilefish are discarded. Tilefish have very specific habitat requirements and commercial fishermen report that they are able to eliminate bycatch of tilefish during closed seasons by avoiding known tilefish habitat. In addition, there is no minimum size for tilefish. Given the rare reporting of tilefish discards, the ease with which tilefish bycatch can be avoided, and the lack of minimum size which would require discarding suggest that few tilefish were discarded.

Black Sea Bass

The final models for the binomial on proportion of trips that reported black sea bass discards and the lognormal on DPUE (discards per unit effort) of trips reporting discards were:

Vertical line

Proportion trips reporting discards = Subregion + Year + Number of Crew + Hook Hours Fished

LOG(DPUE) = Days at Sea + Quarter + Year + Number of Crew + Days at Sea*Year + Days at Sea*Number of Crew + Year*Number of Crew + Days at Sea*Quarter

Fish trap

Proportion trips reporting discards = Year + Subregion + Traps Fished

LOG(DPUE)* = Vessel ID + Year + Days at Sea + Vessel ID*Year

*The interaction Vessel ID*Days at Sea was also significant; but if included, the model failed to converge. This was likely due to a poorly populated data matrix. The Vessel ID*Days at Sea interaction was excluded from the final model.

Calculated black sea bass discards, discard rates, discard rate coefficients of variation, and total effort (vertical line=hook hours; fish trap=traps fished) by gear and season are provided in Table 1. Coefficients of variation for the years prior to 2002 were calculated by using the mean variance from the 2002-2010 discard rates, weighted by sample size. Total yearly discards, summed across gears and open/closed seasons are provided in Table 2. Discard rates of vertical line vessels were low during the open season for all years. Closed season vertical line vessel discard rates were an order of magnitude higher than open season discard rates. The closed season discard rates, however, were nominal rates not standardized by the factors included in the vertical line open season models. Calculated discards from vertical line vessels were highest during the closed seasons in 2009-10. Although fishers may not target black sea bass during the closed season, bycatch of black sea bass would be expected to continue due to fishing effort continuing in the shared habitat of black sea bass and other targeted species. Greater numbers of discards was likely due to the landings moratorium, not increased catch rates during the closed season. Vertical line discards, even during the closed season, were very low compared to the yearly discards calculated from commercial traps. This result is not surprising given the preponderance of landings from commercial fish traps.

Yearly open season black sea bass commercial trap discards during ranged from 39,608 to 237,770 fish. The lowest number of discards was calculated for 2010. The reduced number of discards was probably due to the limited open commercial season during 2010. Trap discards during the closed seasons in 2009-10 cannot be reported here due to confidentiality restrictions. More than 98 percent of commercial trap trips reported landings of black sea bass, suggesting that all or nearly all fish trap effort in the South Atlantic was targeting black sea bass. During closed seasons for black sea bass, fishers may not use fish traps, but may use other gears and target other species. Black sea bass discards from fish traps would be expected to be very low in such a scenario.

Literature Cited

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Table 1. Calculated yearly total discards of black sea bass from vertical line and fish trap vessels for each gear and season stratum. Discards are reported as number of fish.

Year	Gear	Season	Discard Rate	Discard Rate CV	Total Effort	Calculated Discards
1993	VL	Open	0.004	0.720	1,139,264	4,581
1994	VL	Open	0.004	0.720	1,427,364	5,740
1995	VL	Open	0.004	0.720	1,402,733	5,641
1996	VL	Open	0.004	0.720	1,348,311	5,422
1997	VL	Open	0.004	0.720	1,314,028	5,284
1998	VL	Open	0.004	0.720	1,070,979	4,307
1999	VL	Open	0.004	0.720	868,841	3,494
2000	VL	Open	0.004	0.720	918,224	3,692
2001	VL	Open	0.004	0.720	1,012,900	4,073
2002	VL	Open	0.005	0.623	964,608	4,407
2003	VL	Open	0.006	0.634	798,636	5,111
2004	VL	Open	0.002	0.723	727,633	1,582
2005	VL	Open	0.004	0.637	686,416	2,509
2006	VL	Open	0.006	0.629	795,797	4,812
2007	VL	Open	0.003	0.627	881,615	2,645
2008	VL	Open	0.002	0.618	897,913	1,347
2009	VL	Open	0.008	0.609	840,087	6,958
2010	VL	Open	0.005	0.619	314,080	1,706
2009	VL	Closed	0.068	10.152	94,306	6,376
2010	VL	Closed	0.037	14.013	398,870	14,869
1993	Trap	Open	3.548	0.376	42,086	149,339
1994	Trap	Open	3.548	0.376	59,398	210,770
1995	Trap	Open	3.548	0.376	51,317	182,095
1996	Trap	Open	3.548	0.376	57,036	202,388
1997	Trap	Open	3.548	0.376	51,837	183,940
1998	Trap	Open	3.548	0.376	52,728	187,102
1999	Trap	Open	3.548	0.376	48,826	173,256
2000	Trap	Open	3.548	0.376	36,202	128,460
2001	Trap	Open	3.548	0.376	44,106	156,507
2002	Trap	Open	1.852	0.606	34,847	64,521
2003	Trap	Open	5.205	0.399	31,844	165,738
2004	Trap	Open	3.659	0.416	31,886	116,664
2005	Trap	Open	7.429	0.495	24,626	182,950
2006	Trap	Open	7.506	0.518	31,678	237,770
2007	Trap	Open	2.460	0.367	25,155	61,890
2008	Trap	Open	3.461	0.221	18,991	65,729
2009	Trap	Open	3.558	0.255	27,024	105,914*
2010	Trap	Open	2.936	0.296	13,490	40,134*
2009	Trap	Closed	Confidential data			
2010	Trap	Closed	Confidential data			

*****includes discards from closed season fish traps

Table 2. Calculated yearly commercial black sea bass discards from fish trap and vertical line vessels. Discards are reported in number of fish.

Year	Calculated discards
1993	153,920
1994	216,509
1995	187,736
1996	207,810
1997	189,224
1998	191,408
1999	176,749
2000	132,153
2001	160,580
2002	68,929
2003	170,848
2004	118,246
2005	185,460
2006	242,582
2007	64,535
2008	67,076
2009	119,248
2010	56,709

Figure 1. Coastal Logbook statistical areas.