Black Sea Bass and Tilefish Discard Mortality Working Paper

SEDAR 25 Discard Mortality Ad Hoc Working Group

Members Include: Chip Collier, Kenny Fex, Paul Rudershausen, Beverly Sauls

Abstract

Discard mortality is an important estimation included in stock assessments and rebuilding projections calculated from a stock assessment. SEDAR 2 used a 15% discard mortality rate for black sea bass in the commercial and recreational fishery. A review of the literature found published discard mortality rates to range between 0.7 and 66.3%. Commonly referenced factors for estimating black sea bass discard mortality were hooking injury, barotrauma, gear type, and venting. Based on high tag returns (22.5 to 37.3% return rate) and a more recent study conducted by Rudershausen et al. (2010), it appears overall discard mortality rate is low for this species potentially lower than the 15% used in SEDAR 2.

SEDAR 4 assumed 100% discard mortality rate for released tilefish (B2) from the recreational fishery and did not have data on commercial discards. Two tilefish assessments have been conducted in other regions. The Mid-Atlantic stock assessment did not include discard mortality since the numbers of discards were very low in the dominant fishery. The Gulf of Mexico assessment assumed 100% discard mortality for tilefish based on the depth where fish have been caught. No assessment has used a discard mortality value less than 100% for tilefish if discard mortality was included in the model.

Introduction

Discard mortality is an important estimation included in stock assessments and rebuilding projections calculated from a stock assessment. Discard mortality rate can be impacted by several factors including: fish size, sea conditions, temperature, air exposure, handling, light conditions, sea conditions, and delayed mortality (Davis 2002). The longer fish are exposed to these fishing related factors and the more severe these factors are, the greater the cumulative stress on the fish (Rummer and Bennett 2007). The impacts of many of these factors are difficult to track or quantify and have lead to variability in determining discard mortality rates. The discard mortality rate of South Atlantic black sea bass is of particular concern and was a recommended research recommendation in the review of SEDAR 2 (SEDAR 2003). SEDAR 4 assumed a 100% discard mortality for released tilefish in the recreational fishery (B2) and data were available not for commercial discards (SEDAR 2004).

Several studies have been conducted to estimate a discard mortality rate for black sea bass with values varying from 0.7 to 66.3% (Table 1). Gear, depth, and venting appeared to have an impact on the discard mortality rate. Little data are available for estimating discard mortality for tilefish. The species has been assessed in by the Mid-Atlantic Fishery Management Council, South Atlantic Fishery Management Council, and Gulf of Mexico Fishery Management Council. A discard mortality rate was not used in the Middle Atlantic-Southern New England Assessment due to the low number of discarded fish (<1% in the dominant longline fishery) (NEFSC 2009). An assumed discard mortality of 100% was used in SEDAR 22 for the Gulf of Mexico Assessment of tilefish (SEDAR 2010). Neither of these assessments cited any papers discussing discard mortality of tilefish. Due to the depths fished for tilefish in the South Atlantic, it is likely the discard mortality is very high for this species.

In order to address the issue of discard mortality, a working group was put together prior to SEDAR 25. Two primary causes of discard mortality were indentified: hooking related injuries and barotrauma. Secondary factors of black sea bass discard mortality were considered including gear, predation, venting, air exposure, and unreported regulatory discards used as bait. Due to the lack of information on tilefish discard mortality and the general consensus that discard mortality is very high for tilefish, the remainder of the paper will focus on black sea bass.

Hooking Related Injuries

Hooking related injuries were a significant factor in the estimate of discard mortality (Bugley and Shepard 1981, Rudershausen et al. 2007). Fish that were hooked in the jaw had very low mortality rates (0% in Bugley and Shepard 1981 and 2.7% in Rudershausen et al. 2007). However fish hooked in the gut, gill, or eye had a predicted higher discard mortality rate ranging from 4.5% to 66.3% (Bugley and Shepard 1981, Rudershausen et al. 2007). The percent of fish that were hooked in the jaw was high in all studies on black sea bass with 80 to 95.5% jaw hooked depending on hook size and size of the fish (Bugley and Shepard 1991, Rudershausen et al. 2007). Larger fish (>270 mm standard length) were more likely to swallow the hook than smaller fish (<270 mm SL) because larger fish have a larger mouth gape (Bugley and Shepard 1991). A separate hook study of commercial snapper grouper fishing off NC noted a decreasing percentage of gut and gill hooked for non-targeted bycatch fish using larger hooks compared to smaller hooks (Bacheler and Buckel 2004). However a more recent study on hook size and hooking location did not observe reduced foul hooking (hooked in eye, stomach, or gill) for black sea bass with larger hooks (Rudershausen et al. 2007).

Another indication of injuries and mortalities caused by hooking is observed in the difference between the injury reporting and discard mortality rates for fish caught on hook and line and other gears. When the injury/mortality rate of fish caught with hook and line gear was compared to other gears, hook and line caught fish were observed to have a higher injury or mortality rate than trap caught fish (Bugley and Shepard 1991, Rudershausen et al. 2010) and trawl caught fish (Rogers et al. 1986). Bugley and Shepard (1981) used traps as the control or standard to determine the effect hooking injuries on released fish. In that study, no fish suffered a mortality when brought up from depth (<20 meters) in traps. Rudershausen et al. (2010) found black sea bass caught in traps (average discard mortality 0.7%) had a statistically better release condition than black sea bass caught with hook and line gear (average discard mortality 4.3%). Rogers et al. (1986) found significantly lower oval eversions (stomach protruding into the mouth due to gas expansion in swim bladder) in trawl caught black sea bass (2%) compared to black sea bass caught with hook and line (27%).

Barotrauma

All fish with closed swim bladders (physoclistic) suffer barotraumas injuries caused by rapid decompression from depth; however, mortality varies not only by depth but between species based on anatomy, physiology, and behavior. A marine species' swim bladder must not only be kept inflated at 5% of the fish's body volume but at a pressure equal to that of the surrounding water. Swim bladder volume follows Boyle's law which states changes in volume must be inversely proportional to changes in pressure if all other parameters remain constant. This means a decrease in hydrostatic pressure will cause an increase in the volume of gas in the swim bladder. Pressure at the water's surface is 1 atmosphere (atm) and increases by 1 atm, or 14.7 pounds per square inch, per each 10 meters of descent. A fish swimming near the surface is only subject to the pressure of 1 atm. At 10 meters, the pressure increases to 2 atm. When a fish swims up or is pulled up from 10 meters to the surface, the swim bladder expands as pressure decreases. The fish must deflate the swim bladder to prevent over buoyancy inhibiting controlled movement (Marshall 1970). Physoclistic fish are incapable of rapid deflation and rely on diffusion of swim bladder gases via a dense network of bundles of arterial and venous blood capillaries called rete mirable housed within the swim bladder walls. They adjust absorption or secretion of gases as needed. Swim bladder gases, often nitrogen, oxygen and carbon dioxide, diffuse into the rete as long as gas pressure within the swim bladder is greater than that in the capillary blood. Although difference in gas pressure varies with water depth, deflation rate is proportional to the area and complexity of the rete and to circulation speed (Marshall 1970).

The impact of barotraumas on black sea bass varies by depth. The highest immediate discard mortality rates were observed at the deepest depth even though the differences in mortality rates were not always significantly different (Bugley and Shepard 1991, Collins 1999, Collins et al. 1999, Rudershausen et al. 2007, Rudershausen et al. 2008, Rudershausen et al. 2010, Stephen and Harris 2010). Most studies noted that larger fish were observed in deeper waters. Although the discard mortality rate was higher in deeper waters, the number of fish dead fish discarded will likely be much lower in deeper waters.

Venting is a controversial method to release gas trapped in an over-inflated swim bladder due to rapid decompression (Burns et al. 2008, Wilde 2009). The prevalence of venting by commercial and recreational fishermen is unknown in the South Atlantic but has been suggested by several researchers as a potential tool to decrease discard mortality (Rogers et al. 1986, Collins et al. 1999, Rudershausen et al. 2010) and is required in the snapper grouper fishery in the Gulf of Mexico. Other methods to reduce discard mortality should be considered and developed to reduce discard mortality for a variety of snapper grouper species because secondary factors such as increased handling time, impacts of temperature changes, and needle injury may reduce benefits associated with a venting management strategy (Rudershausen et al. 2010). Recompression techniques have been shown to increase survival by returning fish to depths greater than 2 to 3 atmospheres (60-100 feet) compared to fish without any recompression treatment (FishSmart 2011).

Secondary Discard Mortality Factors

Other factors for consideration when calculating discard mortality include: deck time, predation, use as bait, size correlation with discard mortality, and injury due to venting. Deck time was not a significant factor for predicting release condition (Rudershausen et al. 2008). Predation was not significant on natural reefs but maybe higher on wrecks and artificial reefs where greater amberjack and king mackerel abundances were higher (Rudershausen et al. 2010). Recreational angler intercepts for the Marine Recreational Fisheries Statistics Survey collect data on disposition of recreationally caught fish, and fish used for bait count towards harvested catch and are not included in estimates for discards. Regulatory discards of black sea bass were not reported to be used as bait in the commercial snapper grouper fishery (Stephen and Harris 2010). Size of discarded fish was not a significant factor in determining the fate (floating or not floating) for black sea bass (Rudershausen et al. 2007).

Tagging studies have reported relatively high recapture rates for black sea bass between 22.5% and 37.3% (Moe 1966, Beaumariage 1969, Ansley and Harris 1981). These studies did not report information on reporting rates by the recreational and commercial fishermen and/or tag retention rates in black sea bass. Due to the lack of these two critical components, overall discard mortality could be accurately estimated from tagging studies. Recently, a tagging study was conducted in the South Atlantic for black sea bass by Rudershausen et al. (2010) using methods described by Hueter et al. (2006). This study combined the total number of black sea bass observed in each at-sea release condition with the survival estimates for each release condition based on tag returns to estimate the weighted discard mortality rate. One key assumption of this study was that the fish in the best release condition are assumed to survive at 100%. Given the high rate of tag returns and low predation rates for released fish (Rudershausen et al. 2010), the survival of fish in the best condition seems very close to the predicted (100%). Rudershausen et al. (2010) reported a discard mortality of 4.3% for hook and line caught fish and 0.7% for trap caught fish although it may slightly underestimate discard mortality if fish released in the best condition survive 100% of the time.

Estimates of Black Sea Bass Discard Mortality

High recovery rates of tagged black sea bass indicate discard mortality may be potentially lower than the current 15% recommended in SEDAR 2 (Moe 1966, Beaumariage 1969, Ansley and Harris 1981, Rudershausen et al. 2010). However, two studies reported discard mortality above 60% for black sea bass. One study was based on a modeling approach that used data from several different species to estimate median probability of discard mortality based on the hook location and depth fished (Rudershausen et al. 2007). The other study was observer based discard mortality on commercial hook and line vessel (Stephen and Harris 2010). Both of these studies assumed 100% mortality for fish released in poor condition and estimated mortality for depths deeper than typically fished for black sea bass (Rudershausen et al. 2008, Collier and Stewart 2010). Secondary factors such as predation, internal injuries not observed at the surface, and cumulative impacts of multiple captures may contribute to higher discard mortality than observed using surface disposition alone. Tag-recapture studies can provide a relative measure for long-term survival for fish released under variable conditions and can be used to estimate the impact of different factors. Rudershausen et al. (2010) calculated fishery specific discard mortality rates of 4.3% for hook and line caught fish and 0.7% for trap caught fish based on the release condition of fish observed in each fishery. Venting may reduce discard mortality particularly for fish captured in deeper water (>40 m) (Collins et al. 1999) although data on depth of capture may not be readily available for all fisheries and the number/percent of fishermen that vent fish remains unknown.

Hook and line gear appears to have a higher discard mortality rate than either trawl gear (no longer an allowable gear to harvest snapper grouper species south of Cape Hatteras) or commercial traps (Rogers et al. 1986, Bugley and Shepard 1991, Rudershausen et al. 2010). Little information is available to determine if different sectors of the recreational fishery have different discard mortality rates. Depth fished, hook type, recompression techniques, season, and hook size should all be investigated to further refine estimates of discard mortality for releases in past fisheries and potential benefits of management regulations that can be included in rebuilding projections.

Literature Cited

Ansley, H.L. and C.D. Harris. 1981. Migration and standing stock of fishes associated with artifical and natural reefs on Georgia's outer continental shelf. Georgia Department of Natural Resources, Coastal Resources Division. 39p.

Bacheler, N.M. and J.A. Buckel. 2004. Does hook type influence the catch rate, size, and injury of grouper in a North Carolina commercial fishery? Fisheries Research 69: 303-311.

Beaumarriage, D.S. 1969. Returns from the 1965 Schlitz tagging program including a cumulative analysis of previous results. Florida DENR Technical Series 59: 38p.

Bugley, K., and G. Shepherd. 1991. Effect of catch-and-release angling on the survival of black sea bass. North American Journal of Fisheries Management 11: 468-471.

Burns, K.M., N.J. Brown-Peterson, R.M. Overstreet, J. Gannon, P. Simmons, J. Sprinkle and C. Weaver. 2008. Evaluation of the Efficacy of the Current Minimum Size Regulation for Selected Reef Fish Based on Release Mortality and Fish Physiology. Mote Marine Laboratory Technical Report No. 1176 (MARFIN Grant # NA17FF2010) 75 p.

Collier, C. and C.B. Stewart. 2010. Age sampling of commercial snapper grouper fishery and age description of the black sea bass fishery in North Carolina. MARFIN Completion Report Grant NA06NMF4330057. North Carolina Division of Marine Fisheries, Morehead City, NC 70p.

Collins, M.R. 1999. Survival estimates for demersal reef fishes released by anglers. Proceedings of the Gulf and Caribbean Fisheries Institute 44: 259-269.

Collins, M.R., J.C. McGovern, G.R. Sedberry, H.S. Meister, R. Pardieck. 1999. Swim bladder deflation in black sea bass and vermilion snapper: potential for increasing postrelease survival. North American Journal of Fisheries Management 19: 828-832.

Davis, M.W. 2002. Key principles for understanding fish bycatch discard mortality. Canadian Journal of Fisheries and Aquatic Sciences 59: 1834-1843.

FishSmart. 2011. Guidelines specific for saltwater fish caught in deep water. http://www.fishsmart.org/Reports/workshopnews.pdf. Accessed 4/2/2011.

Hueter, R.E., C.A. Manire, J.P. Tyminski, J.M. Hoenig, and D.A. Hepworth. 2006. Assessing mortality of released or discarded fish using a logistic model of relative survival derived from tagging data. Transactions of the American Fisheries Society 135: 500-508.

Marshall, N.B. 1970. 'Poissons sans poids'. *The Life of Fishes*. Universe Books. New York. p. 67-80.

Moe, M.A., Jr. 1966. Tagging fishes in Florida offshore waters. Florida Board of Conservation, Marine Laboratory Technical Series 49: 40p.

NEFSC (Northeast Fisheries Science Center). 2009. 48th Northeast Regional Stock Assessment Workshop (48th SAW) Assessment Report. US Department of Commerce, Northeast Fishery Science Center Reference Document. 09-15; 834 p.

Pollock, K.H. and W.E. Pine III. 2007. The design and analysis of field studies to estimate catch-and-release mortality. Fisheries Management and Ecology 14: 123-130.

Rogers, S.G., H.T. Langston, T.E. Targett. 1986. Anatomical trauma to sponge-coral reef fishes captured by trawling and angling. Fishery Bulletin 84: 697-703.

Rudershausen, P.J., M.S. Baker, Jr., and J.A. Buckel. 2008. Catch rates and selectivity among three trap types in the U.S. South Atlantic black sea bass commercial trap fishery. North American Journal of Fisheries Management 28: 1099-1107.

Rudershausen, P.J., J.A. Buckel, T. Burgess. 2010. Estimating discard mortality of black sea bass (*Centropristis striata*) and other reef fish in North Carolina using a tag-return approach. Combined Final Report: NC SeaGrant FRG 07-FEG-01 and 09-FEG-04. 33p.

Rudershausen, P.J., J.A. Buckel, E.H Williams. 2007. Discard composition and release fate in the snapper and grouper commercial hook-and-line fishery in North Carolina, USA. Fisheries Management and Ecology 14: 103–113.

Rummer, J. L., and W. A Bennett. 2005. Physiological effects of swim bladder overexpansion and catastrophic decompression on red snapper. Transactions of the American Fisheries Society 134: 1457–1470.

SEDAR 2003. SEDAR 2: Complete assessment and review report of South Atlantic black sea bass. South Atlantic Fishery Management Council, Charleston, SC, 60 p.

SEDAR 2004. SEDAR 4: Stock assessment of the Deepwater Snapper-Grouper Complex in the South Atlantic. South Atlantic Fishery Management Council. Charleston, SC. 594 p.

SEDAR 2010. SEDAR 22 Gulf of Mexico Tilefish Section II: Data Workshop Report. SEDAR, Charleston, SC. 92 p.

Stephen, J. A. and P. J. Harris. 2010. Commercial catch composition with discard and immediate release mortality proportions off the southeastern coast of the United States. Fisheries Research 103: 18-24.

Wilde, G.R. 2009. Does venting promote survival of released fish? Fisheries 34: 20-28.

Table 1. Black sea bass discard mortality studies, method used to estimate mortality, gear used, area where the study occurred (SA=South Atlantic and MA=Mid Atlantic), estimate of discard mortality, impact of depth on discard mortality, and other effects contributing to the estimate of discard mortality.

Author	Method	Gear	Area	Estimate	Depth Effect	Other Effects
Bugley and Shepard 1981	Tagging/Pots	H&L	MA	4.7	Positive but not significant	Hooking
Collins 1999	Observer/Tank	H&L	SA	22-38	Positive but not significant	
Collins et al. 1999	Cage	H&L	SA	0-39	Positive	Venting Helped
Rudershausen et al. 2007	Observer/Modeling	H&L	SA	3.6-65.7	Positive but not significant	
Rudershausen et al. 2008	Observer	Trap	SA	2.1-5.9	Positive	Density
Rudershausen et al. 2010	Tagging	H&L	SA	4.3	Positive but not significant	Venting Helped
Rudershausen et al. 2010	Tagging	Trap	SA	0.7	Positive but not significant	Venting Helped
Stephen and Harris 2010	Observer	H&L	SA	66.3		
SEDAR 2	Review	All	SA	15		
SARC43	Review	All	MA	15		

Table 2. Discard mortality factors for black sea bass.

Factor	Significance	Studies
Gear	Hook and line higher	Rogers et al. 1986, Bugley and Shepard 1991, Rudershausen et al. 2010
Temperature	Unknown (Higher return rates during winter)	Ansley and Harris 1981
Season	Unknown (Higher return rates during winter)	Ansley and Harris 1981
Deck Time	NS	Rudershausen et al. 2008
Use as Bait	Unknown (One report)	Stephen and Harris 2010
Size	NS	Rudershausen et al. 2007
Size*Hook		
Location	Varies	Bugley and Shepard 1991, Rudershausen et al. 2010