Utility and Usage of Descender Devices in the Red Snapper Recreational Fishery in the South Atlantic

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Utility and Usage of Descender Devices in the Red Snapper Recreational Fishery in the South Atlantic

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The proportion of regulatory discards in American Red Snapper (*Lutjanus campechanus*: hereafter Red Snapper) fisheries has increased tremendously over the past several decades, sparking concern over the fate of discarded fish within both commercial and recreational fisheries. Several recent studies have assessed Red Snapper barotrauma and release condition with specific topics including immediate release mortality (Rummer 2007, Pulver 2017), the relationship between capture depth and discard mortality (Campbell et al. 2010b, Campbell et al. 2014), and the impact of barotrauma mitigation measures such as venting or recompression devices (Drumhiller et al. 2014, Sauls et al. 2016, Tomkins 2017, Ayala 2020, Bohaboy et al. 2020). The probability of anglers employing best release practices can also influence the overall survival within the fishery. Here we review Red Snapper release mortality under varying barotrauma mitigation scenarios and examine the current employment of barotrauma mitigation methods within the fishery. Using this information, we estimate the total mortality of Red Snapper caught and released in the South Atlantic recreational fishery under several release treatment scenarios.

Angler Preferences and Likelihood of Employing Descending Devices

Regardless of biological outcomes, angler likelihood of using barotrauma mitigation must be considered when calculating total survival of released fish. Ease of use and angler attitudes often drive angler behaviors, impacting the overall efficacy any suggested or mandated catch and release (CAR) mortality mitigation method. In the early 2000's the use of venting tools became popular in reef fisheries throughout the southeastern US. When surveyed about the perceived effectiveness of venting, offshore anglers that fished in the northern and eastern Gulf of Mexico indicated that they observed mitigation being most effective for Red Snapper caught between 20 and 40 m. These anglers reported using venting tools 85% of the time when catching reef fish (Scyphers et al. 2013). Additional surveys of Florida reef-fish anglers found that 68-71% had observed fish exhibiting gross barotrauma (Adams et al. 2017, Crandall et al. 2018). Most (80-92%) reported using some form of barotrauma mitigation and a majority (69%) said that they always used barotrauma mitigation when needed (Adams et al. 2017, Crandall et al. 2018). Despite the removal of the rule requiring venting gear, most anglers continued to use barotrauma mitigation in Gulf of Mexico recreational reef fisheries (Crandall et al. 2018), suggesting high confidence in the of post-release outcomes with mitigation and a willingness of anglers to participate.

The use of descending devices was first popularized in the rockfish (*Sebastes* spp.) fisheries off the California coast. In the southeastern US, familiarity with descending devices has steadily increased over the past decade. A survey in the spring of 2014 found that only about 9% of Florida anglers were familiar with descenders (Adams et al. 2017), but within three years, that number increased to between 30% and 50% (Crandall et al. 2018, Curtis et al. 2019). In a study aimed at increasing familiarity with the devices, researchers distributed over 1,000 SeaQuilizer brand descenders to Gulf of Mexico and South Atlantic reef-fish anglers. After using the devices for several months, 70% of anglers reported that they preferred to use descenders over venters, 80% said they thought that descenders could be helpful to the fishery, and 89% said they would use them in the future (Curtis et al. 2019), suggesting that with appropriate outreach, the method could become common practice in the fishery.

Catch-and-release mortality in American Red Snapper

CAR mortality in reef fishes has been shown to depend on several factors including water temperature, capture depth, post-release treatment such as venting or descending, and post-release predation. CAR mortality has been examined in a few reef-fish species in the South Atlantic, including Black Seabass *Centropristis striata* (Rudershausen et al. 2014, Rudershausen et al. 2020), Gray Triggerfish *Balistes capriscus* (Runde et al. 2019), and several grouper species [Snowy Grouper *Epinephelus niveatus*, Scamp *Mycteroperca phenax*, and Speckled Hind *Epinephelus drummondhayi;* Runde and Buckel (2018)]. However, due to physiological differences, CAR mortality estimates are not similar among these disparate genera. The current literature on Red Snapper CAR survival have primarily been conducted in the Gulf of Mexico with additional data from Florida's east coast.

Several authors have investigated the sources of CAR mortality in Red Snapper including water temperature, fishing depth, fish size, and other factors. Rapid swim bladder inflation leads to catastrophic decompression syndrome, which impacts survival outcomes, which is directly related to capture depth. Therefore, fishing depth contributes substantially to Red Snapper CAR mortality. An early study (Rummer 2007) estimated that mortality in released Red Snapper not treated for barotrauma was approximately 20% in depths less than 20 m, but increased with depth, reaching 100% deeper than 110 m. In the meta-analysis by Campbell et al. (2014), overall CAR mortality increased with depth regardless of sector (commercial or recreational) and barotrauma mitigation treatment. Average mortality ranged from 0.199 to 0.667 with lowest mortality in the shallowest water (0-5 m) and highest in the deepest water (100 m). Several additional studies have shown that barotrauma becomes a major factor in the survival of Red Snapper caught between 20 and 30 m depth (Campbell 2008, Campbell et al. 2010a, Burns and Froeschke 2012).

Barotrauma mitigation measures, such as venting and recompression, can improve CAR outcomes in Red Snapper (Drumhiller et al. 2014, Curtis et al. 2015, Sauls et al. 2016, Eberts and

Somers 2017, Ayala 2020). In a study using hyperbaric chambers to simulate venting, descending and surface release, researchers found 100% survival at 30 m (simulated) whether the fish were vented or recompressed but fish that underwent no barotrauma mitigation had a 67% survival rate. Mortality differences increased substantially at simulated deeper depths, with a survival between 83 and 100% for treated (vented or recompressed) fish and 17% for untreated fish at 60 m (Drumhiller et al. 2014).

A conventional tagging study conducted by Florida Fish and Wildlife Conservation Commission Fish and Wildlife Research Institute (FWRI) examined depth-dependent discard mortality for Red Snapper off both the east and west coasts of Florida (Sauls et al. 2017). The work used a proportional hazards model to estimate overall discard mortality within the fishery (Sauls 2013, Sauls et al. 2017). The researchers assigned discarded fish to one of three categories and calculated the proportional survival for each category based on tag-returns. The study found that fish released in good condition with no intervention were the most likely to survive. For Florida's Atlantic coast, the authors used a range of 85-100% survival for these fish, based on literature that suggests high survival in shallow depths where the majority of fish in this condition were observed. Model estimated survival was ~70% for vented fish and ~46% for impaired fish based on differences in recapture rate among treatments (Sauls et al. 2017). In another conventional tagging study off the west coast of Florida, FWRI personnel captured Red Snapper from 30-55 m and assigned individual fish to either be released at the surface or descended to a randomly assigned depth. Fish released at the surface were only vented if they showed signs of barotrauma, similar to what is typically observed in the fishery (Sauls et al. 2017). Video observations during descent indicated that Red Snapper regained strong swimming ability upon reaching 6 m depth and that descending fish to 20 m was likely sufficient to improve survival, regardless of capture depth (Sauls et al. 2016). Descended fish that were tagged prior to release were 5.8% more likely to be recaptured compared to fish that were vented and released at the surface, suggesting fish suffered less latent mortality when descended (Ayala 2020).

Several field studies have used acoustic telemetry to compare release mortality rates between Red Snapper that undergo barotrauma mitigation and untreated fish released at the surface. In the northwestern Gulf of Mexico, Curtis et al. (2015) found an overall survival rate of 72% with both venting and recompression, but 60% survival with no treatment. The lowest survival (14%) was for fish captured at 50 m depth and released untreated at the surface during summer months, when surface water temperatures were highest and the thermocline was steepest. Another study in the western Gulf of Mexico found the odds of survival decreased as capture depth increased, but fish benefited from recompression at all depths (Tomkins 2017). In the northeastern Gulf of Mexico, Bohaboy et al. (2020) explored the difference in survival between fish that were descended and those that were released at the surface with no treatment. Fishing in depths of 30-60 m, researchers found that average 2-day survival was 64% (CI = 59-82%) for descended fish and 44% (CI = 28-56%) for fish released at the surface. Like other studies, they also found that temperature and season had a significant impact on survival of released fish.

Analyses that have compared various treatments of released Red Snapper have concluded that descending gear is useful and should be encouraged between 25 and 55 m depth. In water shallower than 25 m, fish are often able to return to the bottom without assistance. Deeper than 55 m, research has found that the trauma associated with being retrieved from depth is extreme, resulting in little survival difference between fish treated for barotrauma and fish not treated (Curtis et al. 2015, Pulver 2017, Bellquist et al. 2019). Although descending devices do have several advantages over both venting and not treating fish for barotrauma, these devices are not a panacea for the problem of barotrauma in the snapper/grouper fishery. Anglers have noted that large fish require large weights for successful recompression, which may lead to increased total handling time. Anglers have also noticed that certain brands of descending devices only work well with certain sizes of fish (Ayala pers. comm). While finding and promoting best practices for the survival of released fish is always the goal, proper training and outreach to fishers is needed to ensure the use of the most appropriate devices to produce desired outcomes.

Goal and Objectives

The goal of this analysis is to provide a range of catch-and-release mortality estimates for Red Snapper within the South Atlantic recreational fishery, assuming varying levels of descender use among anglers. To calculate this estimate, we reviewed the available literature on Red Snapper CAR mortality, calculated the differential mortality for various post-release treatment options (no treatment, vent, or descend), and applied potential reductions to current estimated discard mortality rates within the recreational hook-and-line fishery. Given that angler compliance may be less than 100%, estimates are provided for a range of potential recompression prevalence within the fishery (25-100%).

Methods

Current rates of barotrauma mitigation within the SA Red Snapper recreational fishery

To estimate current levels of barotrauma mitigation within the Red Snapper recreational fishery, we summarized data from angler behavior studies conducted by the Florida Fish and Wildlife Conservation Commission and Georgia Department of Natural Resources. These summaries provide a range of estimates regarding angler engagement in barotrauma mitigation.

Florida Fish and Wildlife FDM East Coast Red Snapper Angler Interviews

During the South Atlantic Red Snapper season, the Fisheries Dependent Monitoring (FDM) program of the Florida Fish and Wildlife Conservation Commission conducts targeted interviews at major angler intercept sites in close proximity to each inlet that provides access to the South Atlantic Ocean along Florida's east coast. During 2018 and 2019 these interviews included questions concerning the use of various barotrauma mitigation measures for anglers releasing Red Snapper.We summarized these data to indicate recent prevelence of descender and venting device usage, in addition to average fishing depth on Red Snapper trips by recreational anglers (primarily private anglers) from the east coast of Florida. We compared release depth by barotrauma mitigation method using a Kruskal-Wallis test and a Dunn post-hoc test for pairwise comparisons.

Georgia DNR Catch Card Program

We summarized the results of a catch card survey conducted in 2018 and 2019 by the Georgia Department of Natural Resources. Anglers filled out catch cards and left them with their Red Snapper carcasses during a carcass drop-off program. These catch cards may not be representative of the broader recreational fishery in the region. Rather, anglers participating in a carcass-drop program are thought to be more heavily invested in the fishery and may represent the most avid anglers. However, these data are useful to illustrate the upper limit of angler engagement and to project the use of mitigation devices going forward.

Red Snapper CAR survival using various barotrauma mitigation measures

We summarized five Gulf of Mexico Red Snapper CAR studies to estimate survival using various barotrauma mitigation measures. Each study reported percent survival or percent recapture of Red Snapper caught and released between 30 and 80 m depth. One study used captive fish in recompression chambers (Drumhiller et al. 2014), one used conventional tags (Ayala 2020), and three used ultrasonic telemetry to follow individual fish over time (Curtis et al. 2015, Tomkins 2017, Bohaboy et al. 2020). While each study used slightly different methods, fish could be categorized as released at the surface with no intervention, vented, or recompressed.

To calculate mean differential survival between fish that were descended and those that were either vented or untreated, we used paired values within each available published study to calculate the net increase in survival percentage (if applicable) when fish were descended (Table 3). The paired differences were averaged to get the mean increase in survival percentage across all studies. Survival percentages currently estimated within the recreational hook-and-line fishery (Sauls et al. 2017) were then used as a baseline upon which to increase survival under varying assumptions about release methods that may be practiced in the future (Table 3).

Estimating current levels of Red Snapper barotrauma mitigation

Along the east coast of Florida, portions of the recreational for-hire fishery have been monitored with fishery observers from FWC continuously since 2011.These data were used to quantify the numbers of Red Snapper captured and released at various depths within the recreational hook-and-line fishery in each of three release condition categories (Sauls et al. 2017) Discarded fish were considered to be released in “Good” condition if they were not vented and re-submerged on their own, “Vented” if they re-submerged on their own after being vented, or “Impaired” if they exhibited difficulty re-submerging, had severe hooking injuries, or had other observed issues upon release. Each discarded fish was marked with a conventional tag prior to release, and mark-recapture data were used to model the relative recapture rates and estimate survival percentages for fish released in each of the three condition categories (Sauls et al. 2017)

Proportional CAR mortality under varying proportions of descender use

For this analysis, we assumed varying percentages of "Vented" and "Impaired" fish that were observed in the fishery, from each 10 meter capture depth bin, were instead descended. For the portion of fish that remained in "Vented" and "Impaired" categories, the original estimated survival percentage was applied, and an increased survival percentage was applied to the portion of fish that were moved into the descended category. The amount that the survival percentage was increased by was based on the average increase for descended versus surface released fish calculated from the literature. Finally, we calculated total CAR mortality in the Red Snapper recreational fishery using the proportions of fish released in each depth and impairment category. We calculated an estimate from the charter fishery observer data to represent the charter and private fishery. We calculated a separate estimate using the observer data from the headboat fishery.

Results

Florida Fish and Wildlife FDM East Coast Red Snapper Angler Interviews

A total of 801 boat parties that were randomly intercepted in dockside surveys along the east coast of Florida during South Atlantic Red Snapper seasons reported releasing Red Snapper alive. Over 52.8% of boat parties reported fishing in 21-30 m. An addition 18.2% fished in 11-20 m and 18.9% fished in 31-40 m of water (Figure 1A). Aproximately 1.5% reported using descending devices, over 65% vented at least some of their fish, and 33% said that they used no barotrauma mitigation measures (Table 1). Venting was most prevelent for anglers fishing in more than 30 m of water (80%). While somewhat less prevelant in shallower water, 57% of anglers indicated that they vented fish. The differences in release methods used across depths were signifcant (Kruskal-Wallis $X^2 = 70.547$, $p < 0.05$). All release methods were signifcantly different from one another. Average fishing depth was deepest for anglers using descenders, followed by venters, then surface release (Figure 1B).

Georgia DNR Catch Card Program

In total, anglers completed catch cards associated with 201 trips in which they caught Red Snapper. The catch cards were submitted with carcasses that had been provided to Georgia DNR for research. Of those, 41 trips indicated whether a descender or venting device was used, and 35 indicated releasing Red Snapper alive. Catch cards indicated the release of 255 Red Snapper (Table 2). Of the 41 trips that provided information about descender device use, 32% of fish were not treated, 2% were vented and 65% were released to the bottom with descender devices. Though a small sample size, these proportions are starkly different from the barotrauma mitigation usage reported in the Florida fishery. Average fishing depth for anglers releasing fish was 26 m, similar to depths reported by Florida anglers. These results show a best-case scenario for current angling practices, as the majority of fishing is occurring in shallow depths, with the majority of fishermen reporting that descender devices were used on released fish.

Red Snapper CAR survival using various barotrauma mitigation measures

One study (Ayala 2020) used conventional tagging to estimate proportional differences among post-release treatments. Anonther study (Drumhiller et al. 2014) used hyperbaric chambers to simulate rapid decompression and recomrepssion. The remaining studies used ultrasonic telemetry of Red Snapper in wild CAR scenarios to estimate survival over periods ranging from 12 h to 3 d (Table 3). In each study for which depth was discretely defined, overall survival decreased with increased fishing depth within barotrauma mitigation category.

The average within-study survival difference between fish that were descended and those that were vented was 5.4%. Therefore, for fish being descended, we assumed a survival value that was 5.4% above the calculated survival of fish vented in Sauls et al. (2017). Likewise, the within-study survival difference for fish that were not treated (assumed impaired) and those that were vented was 21%. Therefore, for fish that were impaired at capture and then descended, we increased the calculated survival by 21% (to 67.4%; Table 4).

Florida Fish and Wildlife East Coast For-Hire Angler Observer Program

A total of 6,999 Red Snapper were directly observed to be caught and released in the east coast Florida recreational for-hire fishery. A total of 1,157 Red Snapper were observed released from charter boats and 5,842 were observed released from headboats (Table 5). Charter vessels were more likely to catch and release Red Snapper in deeper depths than headboats with higher total proportion of the Red Snapper discards being observed on charter boats as depth increased (Figure 2).

Estimating current levels of Red Snapper barotrauma mitigation

Within the Red Snapper at-sea observer data, 92% of fish were released in water depths of 20-39 m. The highest overall proportion of released fish (49%) was vented properly and observed swimming toward bottom in 20-30 m of water (Table 6). As depth increased, a higher proportion of fish were impaired upon release (Figure 3) with the highest proportion of impaired fish released in 60 m of water and deeper (Table 6).

Proportional CAR mortality under varying proportions of descender use

Using the mortality estimates for each of the five release categories (Table 4), depth-dependent release mortality ranged from 24 to 40% if 0% descender use was assumed (Table 7). However, depth-dependent mortality could be reduced by 2-6%, under a hypothetical scenario of 50% descender use, and by 5-12% assuming 100% descender use (Figure 4). Total CAR mortality within the charter/private fishery was 27.9% with no desecender use, 24.8% with 50% descender use, and 21.8% with 100% desecender use. For the headboat fishery, total CAR mortality was estimated to be 26.3% with no desecender ue, 23.5% with 50% descender use, and 20.7% with 100% descender use (Table 7).

Discussion & Conclusions

When applied to the total numbers of Red Snapper discarded throughout the South Atlantic region, small differences in mortality can result in substantial savings. Between 2015 and 2019 an annual average of 2.1 million fish were reported discarded within the recreational fishery (pers. Comm. NOAA 2020). Under the current scenario (essentially 0% descender use) approximately 580,000 of these fish ultimately die from the encounter. However, if 50% of released fish were descended, 64,000 fewer fish would die. Under a scenario of 100% descender use, the level of mortality could be reduced to 460,000, a savings of approximately 21%.

By combining several datasets, including angler behavior interviews, at-sea observations, and mortality estimates by release category, we produced hypothetical estimates of mortality with depth for Red Snapper caught and released in the South Atlantic recreational fishery. We showed that while mortality increased with depth, an increase in desecender use could provide substantial savings in terms of CAR mortality within the fishery. While much of the fishery occurs in 20-40 m of water where proprtional mortality differences are small, the large numbers of discarded fish make the savings substantial in terms of numbers of fish surviving a CAR event. These savings will be based, in large part, on angler participation in best release practices, including the use of descending devices. Most anglers in the region are familiar with venting, a different form of barotrauma mitigation. Surveys have shown that anglers do feel confident using barotrauma mitigation and see the value in its use regardless of regulation (Adams et al. 2017, Crandall et al. 2018). In addition, when anglers are given a chance to try descending devices, most do plan to continue using them (Curtis et al. 2019). The results of this analysis suggest that the South Atlantic Red Snapper fishery could see a substantial increase in the total number of fish that survive CAR if the practice of descending fish to mitigate barotrauma when necessary, is widely adopted in the recreational fishery.

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Table 1. Numbers of boat parties interviewed in Florida during the South Atlantic Red Snapper season that reported using various methods to release fish. Depth categories refer to the average fishing depth during the fishing trip. Some anglers did not provide information on the depth they fished, but did provide information about their use of barotrauma mitigation.

Barotrauma mitigation	no depth	≤ 30 m	> 30 m
Descend	0	5	7
Surface Release	22	195	49
Vent	34	269	220
total	56	469	276

Table 2. Georgia DNR catch card data. Total numbers of catch cards completed, numbers of anglers releasing fish, and numbers of anglers indicating they used descending devices, venters, or no barotrauma mitigation. Anglers indicated total numbers of fish released. Max % by barotrauma mitigation is the propotion of fish the anglers using each device indicated that they released alive.

# Trips with catch cards	201
# Indicated barotrauma mitigation	41
# Trips releasing fish	35
# Trips descending fish	22
# Trips venting fish	1
# Trips not treating fish	12
Total Fish released	255
Max % Descended	65.10
Max % Vent	2.35
Max % Not treat	32.65

Table 3. Studies of Red Snapper catch-and-release survival comparing the barotrauma mitigation methods of descending (D), venting (V), or surface release (S). Fishing depths or simulated depths are shown. Duration in days is listed as well as numbers of individual fish, numbers surviving or recaptured and % survival or recapture for the treatment. Note that % recapture reported for Ayala (2020) is total proportion of fish recaptured, not an estimate of total survival.

Study	Captive/Wild	Depth (m)	Treatment	Duration (days)	n	n survive/recap	% survive/recap
Ayala (2020)*	wild	35-52	D	700+	633	72	11.4
Drumhiller et al (2014)	Captive	30	D	21	6	6	100
Bohaboy et al (2020)	wild	30	D	2	30	22	73
Curtis et al (2015)	wild	30	D	3	7	7	100
Tomkins (2017)	wild	30	D	1	14	12	86
Tomkins (2017)	wild	40	D	1	12	10	60
Curtis et al (2015)	wild	50	D	3	18	13	72
Tomkins (2017)	wild	50	D	1	14	7	50
Bohaboy et al (2020)	wild	55	D	2	31	17	55
Drumhiller et al (2014)	Captive	60	D	21	6	5	83
Tomkins (2017)	wild	60	D	1	14	5	35
Tomkins (2017)	wild	80	D	1	15	2	14
Ayala (2020)*	wild	35-52	V	700+	369	21	5.6
Drumhiller et al (2014)	Captive	30	V	1	6	6	100
Curtis et al (2015)	wild	30	V	3	7	6	86
Curtis et al (2015)	wild	50	V	3	9	6	67
Drumhiller et al (2014)	Captive	60	V	21	6	6	100
Drumhiller et al (2014)	Captive	30	S	21	6	4	67
Bohaboy et al (2020)	wild	30	S	2	27	14	52
Curtis et al (2015)	wild	30	S	3	8	6	75
Curtis et al (2015)	wild	50	S	3	26	14	54
Bohaboy et al (2020)	wild	55	S	2	26	9	35
Drumhiller et al (2014)	Captive	60	S	21	6	1	17

Table 4. Calculated percent survival by barotrauma and treatment category. The categories of *Unimpaired*, *Vent*, and *Impaired* are values calculated by Sauls et al. (2017) for the east coast of Florida. The categories of *Descend* and *Impaired + Descend* are calculated based on the within-study survival differences for individual studies that measured mortality in descended, vented, and untreated fish (Curtis et al. 2015, Ayala 2020, Bohaboy et al. 2020).

Survival Categories	% Survival
Good	92.5
Descend	75.9
Vent	70.5
Impaired + Descend	67.4
Impaired	46.4

Table 5. Total numbers of Red Snapper observed caught and released in the Florida east coast recreational fishery.

Depth (m)	Charter	Headboat	**Total**
10-19	20	247	**267**
20-29	566	4848	**5414**
30-39	463	598	**1061**
40-49	51	101	**152**
50-59	41	44	**85**
60+	16	4	**20**
Totals	**1157**	**5842**	**6999**

Table 6. Numbers of Red Snapper released from Florida east coast for-hire fisheries in each of three conditions by depth category. Good (no barotrauma treatment and observed swimming toward bottom), Vented (vented correctly and observed swimming toward bottom), Impaired (e.g. vented incorrectly, had difficulty returning to bottom, had severe hook wounds, etc.)

Depth	Good	Vented	Impaired	Total
10-19	90	152	25	267
20-29	1450	3443	521	5414
30-39	139	812	110	1061
40-49	11	115	26	152
50-59	5	63	17	85
60+	1	9	10	20
Total	**1696**	**4594**	**709**	**6999**

Table 7. Proportional mortality by depth applying varying levels of descender use within the South Atlantic Red Snapper recreational fishery. "All depths" morality is calculated for both the Charter/Private fleet and for the headboat fleet. Each was calculated by applying proportional mortality by depth to the proportion of the catch released within each 10 m depth bin as directly observed in the Florida east coast charter boat and headboat fisheries (Table 5).

Depth	M (0% descend)	M (25% descend)	M (50% descend)	M (75% descend)	M (100% descend)
10-19	0.24	0.23	0.22	0.21	0.19
20-29	0.26	0.25	0.23	0.22	0.20
30-39	0.29	0.28	0.26	0.24	0.23
40-49	0.32	0.30	0.28	0.26	0.24
50-59	0.33	0.31	0.29	0.27	0.25
60+	0.40	0.37	0.34	0.31	0.28
All depths-Charter/Private	0.279	0.263	0.248	0.233	0.218
All depths-Headboats	0.263	0.249	0.235	0.221	0.207

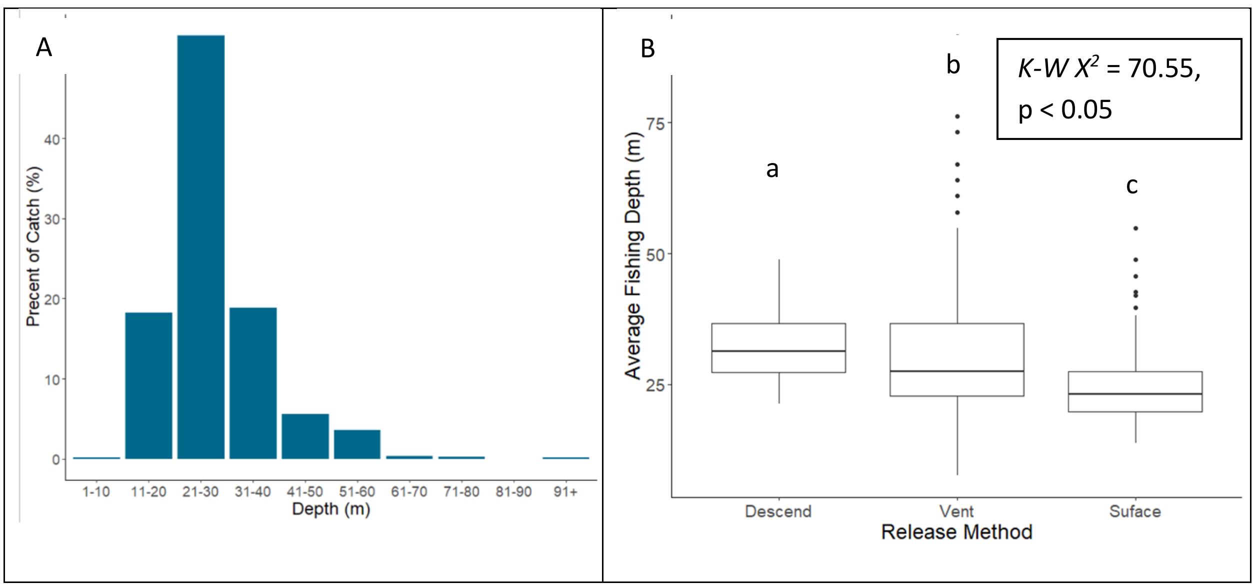

Figure 1. Florida east coast private anglers releasing Red Snapper during South Atlantic open season 2017-2019. A. Average fishing depth. B. Fishing depth as a function of barotrauma mitigation. Horizontal line is the median value, boxes are interquartile range, whiskers are 5% and 95% and dots are beyond 95%. Kruskal-Wallis X^2 is listed. Letters represent significant differences in depth by release type.

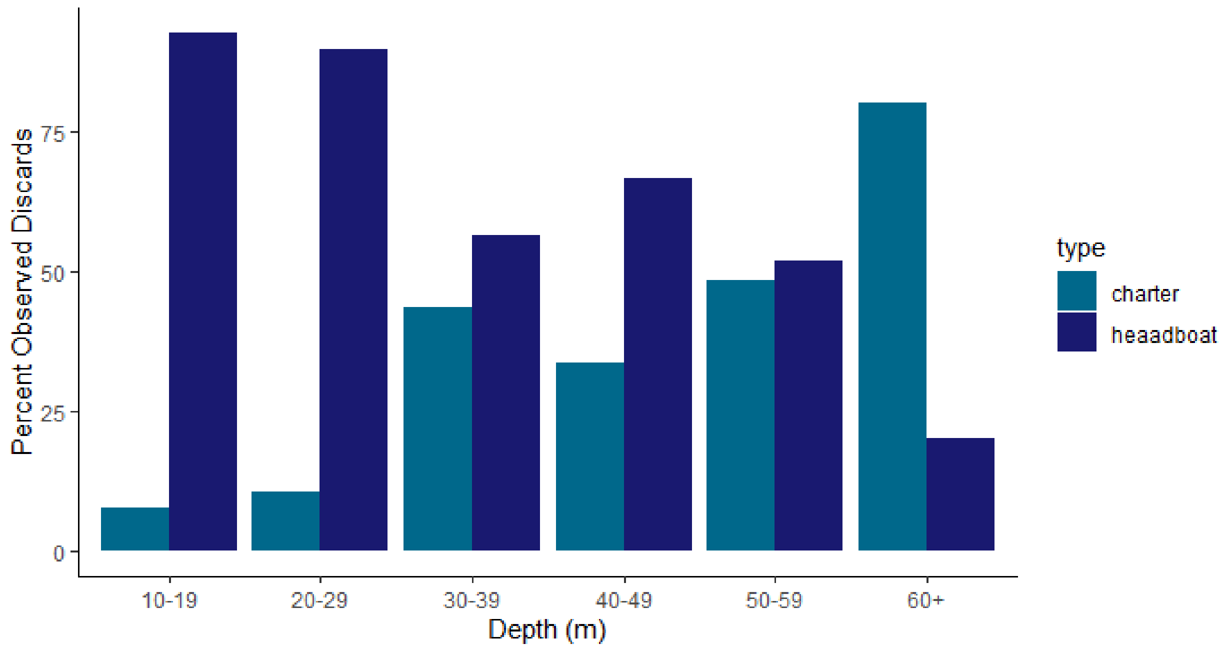

Figure 2. Percent of observed discards in each segment of the for hire recreational fishery by depth category.

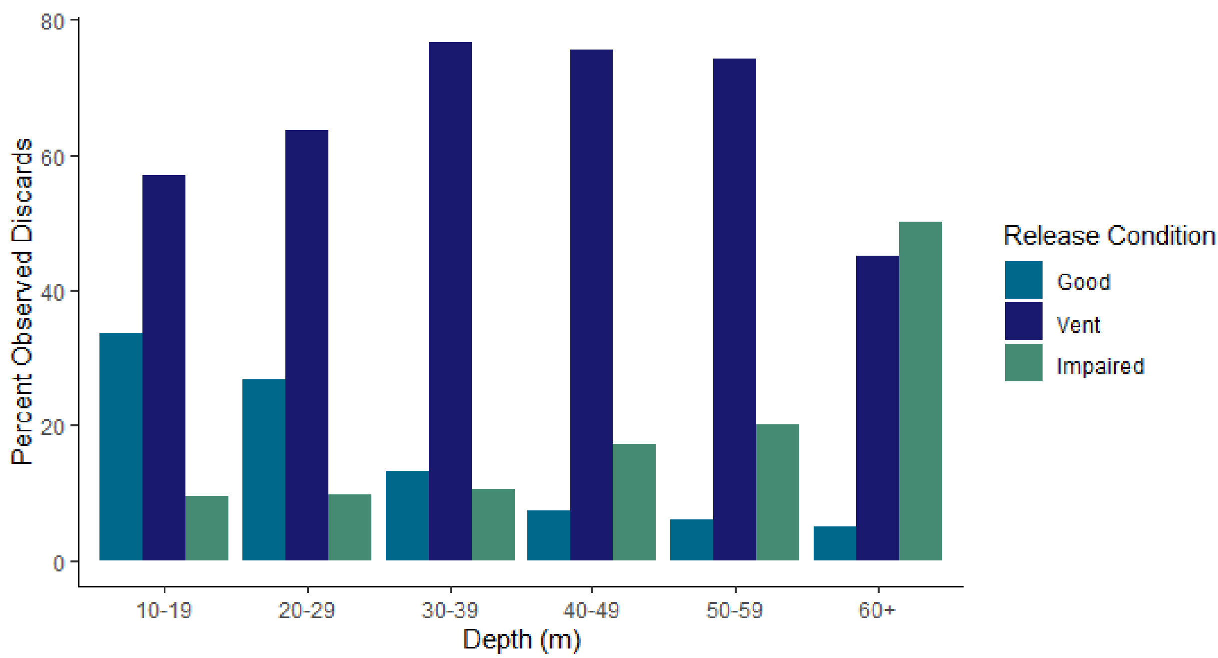

Figure 3. Percent of observed released Red Snapper in each of three categories within the Florida east coast Red Snapper for-hire recreational fishery. Codes are Good (fish was not vented but swam strongly toward bottom), Vented (fish was vented properly and swam strongly toward bottom), and Impaired (fish did not meet either of above conditions).

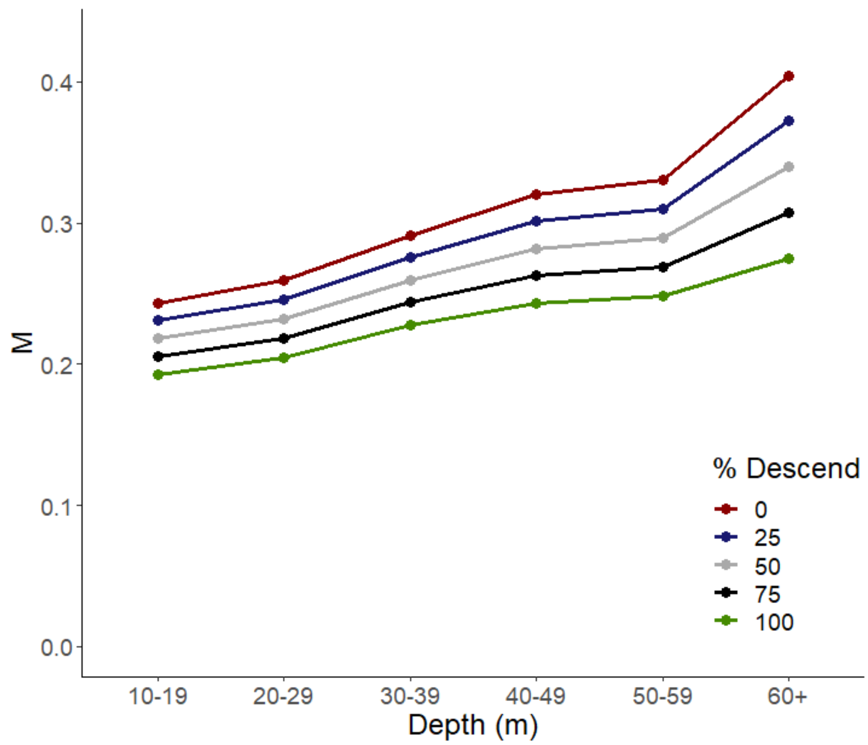

Figure 4. Estimated catch-and-release mortality (M) for Red Snapper in the Florida east coast recreational fishery by depth. M values combine the mortality rates of fish released in one of 5 conditions at each depth (Table 4).