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ARTICLE

Recreational Angler Attitudes and Perceptions Regarding the Use of Descending Devices in Southeast Reef Fish Fisheries

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Abstract

Reducing discard mortality in recreational fisheries remains an important component of stock rebuilding for many reef fish species. Discard mortality for these species can be high due in part to barotrauma injury sustained during capture coupled with high catch rates, but recent advances in fish descending devices can mitigate some of these declines. Despite high survival rates with rapid recompression strategies, recreational angler opinions and perceived effectiveness of the devices are relatively unknown. This study surveyed the perceptions, opinions, and attitudes of 538 recreational anglers regarding the use of descending devices in the reef fish fisheries of the Gulf of Mexico and U.S. South Atlantic, with particular emphasis on Red Snapper *Lutjanus campechanus*. In total, 1,074 descending devices were distributed to marine recreational anglers from North Carolina to Texas. After using the device for an average of 8 months and 15 fishing trips, recipients completed a questionnaire assessing their perceptions on the efficacy of the device. While 72% of respondents had little to no knowledge of descending devices prior to the study, 70% indicated that they preferred this release method over venting after the study. Survey respondents released over 7,000 Red Snapper and 4,000 other reef fish species with their descending devices, and 76% were likely to continue employing the device on their vessel. Eighty-nine percent of respondents believed descending Red Snapper would significantly reduce discard mortality in the recreational fishery. We discovered that recreational anglers perceive the devices to be highly useful in reducing discard mortality and are willing to employ them when releasing reef fish experiencing barotrauma. Other studies have demonstrated that these descending devices do reduce discard mortality of reef fishes, and this study indicates that recreational anglers are very willing to use them as a conservation tool.

Recreational fishing is an important outdoor leisure activity to over 33 million people in the USA (Southwick Associates 2012). It generates substantial income to local, regional, and national economies while providing users an alternative means of domestic consumption (Arlinghaus et al. 2007). Recreational fishing is one of the most popular

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outdoor activities, with economic impacts for saltwater recreational fishing totaling over US$63 billion annually (NMFS 2015). The highest concentration of saltwater recreational anglers resides in the Southeast (North Carolina to Texas), a region that supports over five million saltwater recreational anglers and generates $15 billion in revenue for the economy (NMFS 2012), making it an ideal location to study angler perceptions on fishery-related issues.

Over 50 species of reef-associated fish from nine families are managed by the South Atlantic Fishery Management Council and Gulf of Mexico Fishery Management Council, many of which have been historically overfished or are still undergoing overfishing. Combined recreational landings for South Atlantic and Gulf of Mexico reef fish totaled over 12 million pounds in 2017 (NMFS 2017, 2018), making this southeastern region the largest federally managed recreational fishery in the nation. Yet, many fisheries in the region are overfished and rely on strict regulatory measures, including minimum size limits and closed seasons. For reef fish species such as Red Snapper *Lutjanus campechanus*, discard rates resulting from these regulations are very high and can be even higher outside of the directed fishery due to short, or even absent, summer fishing seasons.

While many recreational anglers retain their catch for consumption, approximately 57% of fish caught in the USA are released (Bartholomew and Bohnsack 2005), and 88% of anglers participate in catch and release during some part of their fishing activity (USFWS 2006). Catch-and-release fishing has become an increasingly popular method to conserve fishery resources through both voluntary practices and also as a requirement through mandated regulations (Cowx 2002; Cooke and Schramm 2007; Brownscombe et al. 2017). Reductions in season length and/or bag limit can result in very high regulatory discard rates, which in some cases are greater than landings for the directed fishery. For example, Gulf of Mexico Red Snapper recreational discard rates have historically on occasion been several times higher out of season than in season (SEDAR 2015). Furthermore, many anglers targeting other species unintentionally catch Red Snapper and are federally mandated to release them when this species is caught out of season. The decision to discard a captured fish can rely on various reasons, such as the fish being perceived as bycatch, regulations in place that require release (bag limits, size limits, closed season), belief that the fish will survive to be captured at a later date, or for ethical reasons (Cooke and Suski 2005). However, an essential assumption in the catch-and-release and discard process is that fish survive long term. While this assumption holds true for many species, postrelease survival for deepwater, physoclistous reef fish is further complicated by barotrauma, which leads to higher discard mortality rates than traditional catch and release occurring at shallower depths (Rummer 2007; Campbell et al. 2014). Barotrauma occurs due to rapid decompression experienced during ascent and has the potential to significantly reduce the odds of survival in Red Snapper and other deepwater reef fish (Rummer and Bennett 2005; Rudershausen et al. 2014; Curtis et al. 2015). Overcoming the issues surrounding barotrauma in catch-and-release fisheries is arguably one of the most important and unresolved complications facing managers today (Arlinghaus et al. 2007).

Fishery managers previously attempted to address barotrauma-induced mortality in the Gulf of Mexico reef fish fishery by promulgating regulations that required anglers to possess a venting tool onboard any vessel fishing in federal waters (GMFMC 2007). Soon after the enactment of the amendment, Wilde (2009) challenged the efficacy of venting discarded reef fish exhibiting barotrauma to increase survival. Additionally, Scyphers et al. (2013) determined that angler experience and knowledge on proper use of the tools was poor, possibly minimizing potential benefits from venting. Wilde (2009) performed a broad meta-analysis to examine the effectiveness of venting to reduce discard mortality in a variety of fish species. His results concluded that venting should be avoided; however, a more recent meta-analysis discovered it to have positive effects (Eberts and Somers 2017). Additionally, the recent development of alternative methods to mitigate barotrauma, such as descending devices, have made the ways to mitigate barotrauma more widely available and more frequently used. Thus, the requirement to possess a venting needle in federal waters of the Gulf of Mexico was rescinded and, more recently, several fishery-governing bodies have initiated new policies to incorporate descending devices into their fishery management plans (GMFMC 2018).

Rapidly recompressing fish using descending devices has been shown to be a successful method to reduce discard mortality in offshore reef fishes (Jarvis and Lowe 2008; Brown et al. 2010; Sumpton et al. 2010; Curtis et al. 2015; Runde and Buckel 2018). However, few studies have specifically examined angler perceptions or their willingness to use descending devices in recreational or commercial fisheries. Crandall et al. (2018) examined the motivating factors for Florida fishers to use venting and descending devices and their willingness to use these devices for barotrauma mitigation through online survey data. Dick (2017) interviewed fishery specialists, scientists, and managers to determine various challenges involved with the devices and to what extent mandating their use in the South Atlantic Red Snapper fishery would be possible. Study participants raised concerns due to a lack of scientific research, limited survey data, and the issue with the multispecies complex in the reef fish fishery. Participants also discussed the importance of angler involvement in the

regulatory process and that trust between managers and stakeholders in the fishery would be vital for moving forward. Thus, more information as to whether anglers are willing to use these tools is certainly essential if managing entities wish to mandate anglers to recompress discarded fish using descending devices as a management strategy in the future.

The primary goal of this study was to evaluate the perceptions and opinions of Gulf of Mexico and South Atlantic recreational anglers regarding the use of descending devices in offshore reef fish fisheries. There perhaps could not be a better model fishery to test the perceptions of these devices than the Gulf of Mexico and South Atlantic Red Snapper recreational fishery. Anglers in these regions have recently been faced with shortened Red Snapper seasons despite recent improvements in the stocks, and the recreational sector contributes a large proportion of the total catch of the fishery. The specific objectives for this project were to (1) obtain angler perspectives on the use and effectiveness of a popular descending device by distributing them to recreational anglers from North Carolina to Texas and following up with a survey questionnaire and (2) compare the perceptions and opinions acquired from survey responses among the three recreational subsectors (private, charter boat, and headboat anglers) to evaluate the potential for required use of the tools in recreational reef fish fisheries.

METHODS

SeaQualizer distribution.—To examine recreational angler perceptions regarding the use of descending devices, partnerships and collaborations were formed with various sportfishing entities to distribute approximately 1,100 descending devices to recreational anglers for use from June 2015 to October 2016. In collaboration with FishSmart (www.fishsmart.org), a science-based program that researches and promotes methods to reduce release mortality in recreational fisheries, agency and nonprofit collaborators distributed a standard model (50–100–150 feet) SeaQualizer to recreational anglers along with information on FishSmart's "best practices" for releasing deepwater fish afflicted with barotrauma. The best practices information includes guidance on assessing fish condition, the effects of barotrauma, and the different types of deepwater release techniques (e.g., venting tools and descending devices) and directs anglers to supplementary online resources on these topics. The best practices states that for deepwater releases, rapidly returning the fish to depth using recompression techniques is the preferred method of choice, followed by venting when rapid descent is not possible. The target population consisted of offshore recreational anglers of the Gulf of Mexico and South Atlantic that targeted reef fish. The majority of devices (79%) were distributed online at www.takemefishing.org/fishsmart, although additional devices were distributed in person at fishing tournaments and club gatherings (5%), through dockside creel stations by project collaborators (5%), and from state agency personnel and other organizations (11%) from the eight Gulf of Mexico and South Atlantic states (Texas, Louisiana, Mississippi, Alabama, Florida, Georgia, South Carolina, North Carolina) (see Acknowledgments). Potential recipients were identified as individuals that were offshore-vessel owners or operators or individuals that were chartering offshore vessels targeting reef fish. Anglers were directed to the FishSmart Web site through articles, postings on social media oriented toward saltwater anglers, and direct mail and email to memberships of angling organizations in the region. The only selection criteria imposed on the Web site registration was that a participant's shipping address had to be within the coastal areas of the study region. Dockside distribution was conducted by agency personnel based on their knowledge and familiarity with the anglers in individual ports. All three subsectors of the federal recreational fishing sector (private anglers; charter captains, owners, and operators; and headboat captains, owners, and operators) were represented in the project. Prior to survey development, researchers engaged with potential participants and established partners from previous projects through informal feedback and conversations to determine appropriate survey questions that would provide optimum data for investigating angler perceptions. Initial attitudes and opinions of anglers acquired during the distribution phase assisted in the construction of the survey questionnaire.

Survey implementation.—Project participants were asked to complete a 30-question online survey concerning the extent of their use, their opinions, and the perceived effectiveness of the SeaQualizer after 8 months (see the appendix for the full survey questionnaire). This provided sufficient time to test their techniques and newly acquired tool on their vessels. Incentives were offered to complete the survey in the form of a random prize drawing, where one of two items could be awarded: a Shimano offshore fishing rod or reel valued at $269.99 or $549.99, respectively. Participants were classified as a private recreational angler; a charter boat captain, owner, or operator; or a headboat captain, owner, or operator and were assigned a home state based on primary fishing port. Estimates of the number of fish released with descending devices during the study was calculated by extrapolating survey responses that quantified the number of discards recompressed by each angler. Questions of particular interest assessed what percent of fish the participants believed survive long term after being released from a descending device and to what extent they will use the device on their vessel in the future. Because Red Snapper are a species of recent debate and

concern regarding barotrauma mitigation, anglers were asked to provide their opinions on how such devices could be helpful or hurtful specifically towards the Red Snapper recreational fishery.

To determine if differences in income, education, fishing experience, and fishing habits affected responses, a secondary portion of the survey was designed to evaluate demographic information and fishing practices. Once respondents had completed the initial portion of the survey, they were offered a secondary incentive for answering an additional nine questions. After completing the secondary portion of the survey, they would be entered into another free drawing to win a separate Shimano rod or reel valued at $269.99 or $649.99, respectively. Demographic questions addressed gender, age, zip code, combined household income, and highest level of education. To determine fishing experience, participants were asked how many days they fished last year and the total number of years they have spent targeting offshore reef fish. Most commonly targeted fishing depth and distance from shore were also identified.

The survey questionnaire was created using SurveyMonkey (SurveyMonkey 2017). Due to the various types of questions in the survey, responses involved multiple formats. The majority of answers were on an ordinal scale (e.g., very unlikely to very likely), though not all answers followed the same ordinal categories. For example, the question addressing angler likeliness to use a descending device to release fish requiring submergence assistance yielded an ordinal scale from "not likely to use at all" to "likely to use it on all fish," while the question asking how helpful respondents believe descending devices would be in reducing discard mortality in Red Snapper yielded an ordinal scale from "not helpful" to "very helpful." Other questions provided nominal answers, binary yes or no answers, and percentage "slide-bar" answers.

Statistical analysis.—The variety of data collected from diverse answer categories necessitated a variety of appropriate statistical analyses to assess various aspects of the survey responses. A key objective in this study was defining differences in perceptions and attitudes about descending devices based on each respondent identifying with a recreational subsector. Analyses with significance testing were used to examine differences between the private and charter subsectors; however, the number of headboat responses prevented statistical comparisons with the other subsectors. Ordinal logistic regression (OLR) was performed when answer categories were on an ordinal scale, a chi-squared test of independence was performed when answers were nominal, and a Kruskal–Wallis test was performed when respondents chose a percentage of 0% to 100% using a slide bar. Likelihood-ratio tests (LRT) were performed when post hoc analysis of OLR models was required. All tests were performed using the statistical package R (R Core Team 2017). Analysis of variance ($\alpha = 0.05$) was used where quantitative comparisons were possible.

RESULTS

Survey Responses

We distributed 1,074 SeaQualizers to recreational anglers in coastal regions from North Carolina to Texas. Of those, a relatively high response rate of 538 completed the survey sent via email (50% response rate), with the majority of responses coming from saltwater anglers in Texas (23%), Alabama (27%), and Florida (28%) (Figure 1). All other states made up less than 10% of respondents. Most respondents (79%) received their SeaQualizer via online registration on FishSmart's Web site. Anglers received educational materials (written and/or video) that included information on best practices for releasing fish (including when to use a descending device) and appropriate use of the SeaQualizer. Approximately 67% of recipients believed the combinations of materials they received improved their knowledge and skills regarding recognition of barotrauma and proper fish handling and release methods.

The vast majority of respondents identified as private recreational anglers ($n = 451$, 84%), while 81 (15%) and 6 (1%) respondents identified as charter boat and headboat captains, owners, or operators, respectively (Figure 1). On average, respondents owned their SeaQualizer 8 months and used it on 15 trips prior to completing the survey. Sixty-eight percent of anglers targeted reef fish in water depths of 38 m or less, 18% targeted depths between 38 m

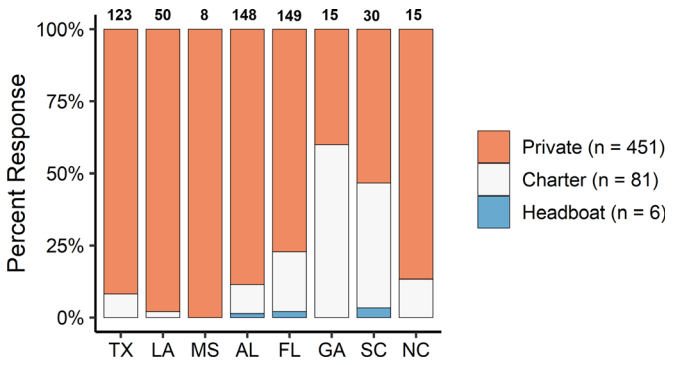

FIGURE 1. Percent response of private, charter, and headboat anglers when asked in which state they most commonly target reef fish. The numbers listed above the stacked bars refer to the total number of respondents from each state, while those listed in parentheses in the legend refer to the total number of respondents from each recreational subsector. State abbreviations are as follows: TX = Texas, LA = Louisiana, MS = Mississippi, AL = Alabama, FL = Florida, GA = Georgia, SC = South Carolina, and NC = North Carolina.

and 53 m, and the remaining respondents (14%) targeted depths greater than 53 m (Figure 2). Similarly, the majority of respondents fished closer to shore when targeting reef fish, with 67% fishing within 30 miles (48 km) of shore.

Most respondents had used a venting tool at some point in the past (89%), with significantly more charter respondents having vented in the past than private anglers (chi-square test: $\chi = 4.314$, $P < 0.05$). When employing venting tools in the past, 78% of respondents vented all or most fish when they exhibited signs of barotrauma. When asked what cues or combination of cues anglers used to determine if submergence assistance was required, 80, 75, 68, 57, and 41% considered a protruding stomach, bloated abdomen, inability to submerge, exophthalmia, and sluggishness to be effective cues, respectively. Twenty-three percent of respondents considered all of those symptoms as useful signs. Thirteen percent used a venting tool or descending device on all fish regardless of symptoms, while 3% never used either. Sixty-three percent of respondents stated they still used venting tools to release fish exhibiting barotrauma. Responses were not significantly different between private anglers and charter boat captains (chi-square test: $\chi = 1.758$, df = 1, $P = 0.185$). For those that did not currently employ venting tools to release fish, 19% stopped using them because they did not think they worked, 17% believed the fish were able to submerge without the help of venting, and 5% stopped using venting tools because they thought they were too time consuming. Sixty-seven percent chose the "other" category and were required to specify their reason. Of those 150 "other" respondents, 66 specifically mentioned they preferred rapid recompression to venting. The mean percentage of fish believed to survive the venting process was 57%, and this was not significantly different between private and charter respondents (Kruskal–Wallis test: $\chi = 0.152$, df = 1, $P = 0.697$).

Previous knowledge concerning the use of descending devices was generally low. Seventy-two percent of respondents had little to no knowledge about descending devices prior to acquiring their SeaQualizer. Only 45 of the 517 respondents (<9%) had a high to very high amount of knowledge prior to receiving their SeaQualizer. Charter boat captains were more likely to possess previous knowledge on the devices than private anglers (OLR: $\beta = 0.521$, $\chi = 5.365$, $P < 0.05$).

The likelihood of respondents to use a descending device to release fish exhibiting barotrauma was very high (Figure 3), and no differences in likeliness-to-use existed between private and charter sectors (OLR: $\beta = -0.2095$, $\chi = 0.821$, $P = 0.365$). Only eight individuals were not likely to use a descending device at all, whereas 33% were likely to use one to release all fish, 43% to release most fish, and 14% to release approximately half of the fish they catch exhibiting barotrauma.

The vast majority of respondents (89%) believed descending devices would be at least "moderately helpful" in reducing discard mortality in the Red Snapper fishery (Figure 4). Seventy-nine percent believed they would be "helpful" to "very helpful." When answers were compared between private anglers and charter captains, private anglers believed the devices to be only slightly more helpful than charter captains did. However, these differences were not statistically significant (OLR: $\beta = -0.407$, $\chi = 2.940$, $P = 0.086$).

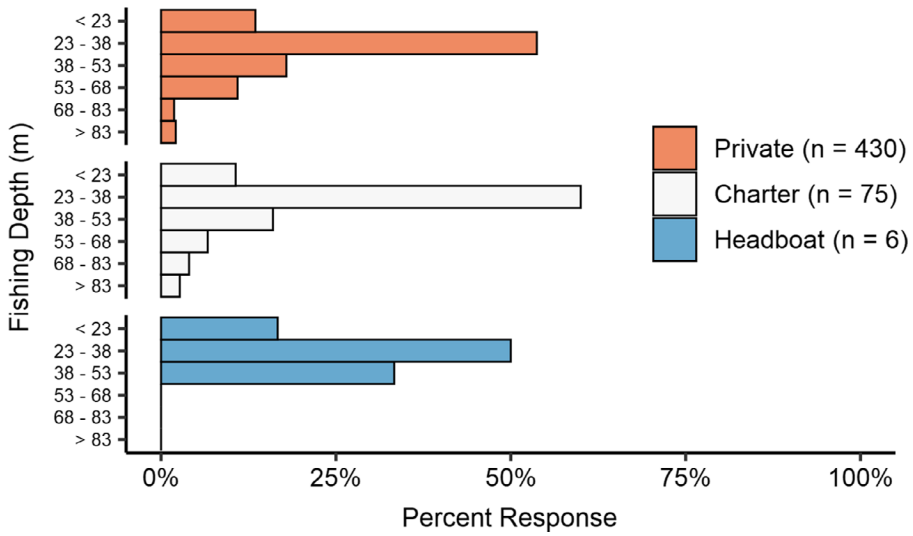

FIGURE 2. Private, charter, and headboat anglers' most commonly targeted depths (meters) when fishing for reef fish. Sample sizes listed in parentheses in the legend correspond to the number of respondents from each recreational subsector.

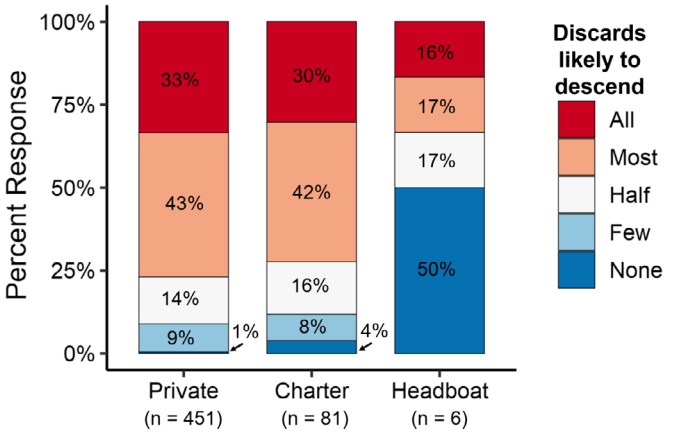

FIGURE 3. Percent response of private, charter, and headboat anglers when asked how likely they were to use a descending device to release fish exhibiting barotrauma. The sample sizes listed under the stacked bars refer to the number of respondents from each recreational subsector.

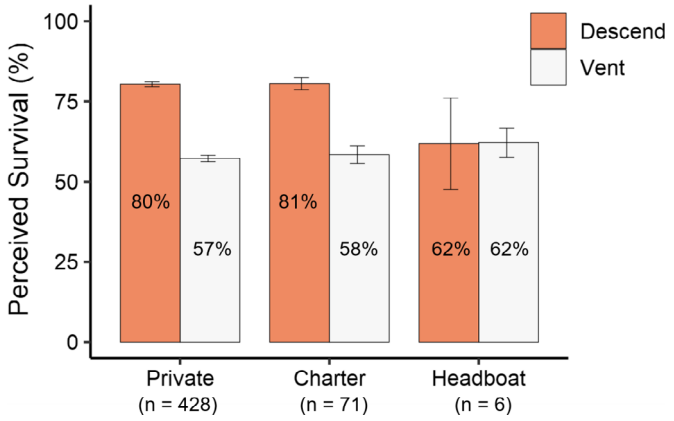

FIGURE 5. Perceived postrelease survival rates associated with descending and venting of discarded reef fish of private, charter, and headboat anglers. Percentages correspond to the perceived proportion of fish that survive once released with either a descending device or venting tool. The error bars represent the standard error of the mean. The sample sizes listed under the stacked bars refer to the number of respondents from each recreational subsector.

Mean perceived survival of reef fish released with descending devices was higher than for vented fish for both private respondents (ANOVA: $F_{1,\ 824} = 327.72$, $P < 0.0001$) and charter respondents (ANOVA: $F_{1,\ 140} = 41.48$, $P < 0.0001$) (Figure 5). The mean predicted survival rate of both descended and vented fish was very similar between private and charter respondents (Figure 5).

A range of the approximate total number of fish released by anglers during this study was calculated by multiplying the number of respondents in one category by the range of the minimum and maximum number of fish released in that category. Throughout the course of this study, survey respondents released a minimum of 7,068 to a maximum of 11,235 Red Snapper and a minimum of 4,316 to a maximum of 6,790 other species of fish. On average, charter captains and private anglers released approximately 28 and 16 Red Snapper per person, respectively, between the time of acquiring their SeaQualizer and completing the survey.

After receiving and using the SeaQualizer, 70% of all participants preferred descending to venting, with private respondents more likely to prefer descending to venting than charter respondents (chi-squared test: $\chi = 24.567$, $P < 0.001$) (Figure 6). After operating the SeaQualizer, 74% of private anglers preferred to release fish with a descending device, whereas 55% of charter respondents preferred descending to other methods. Likewise, 17% of charter captains still preferred venting compared with only 7% of private anglers. Only 4% of respondents still

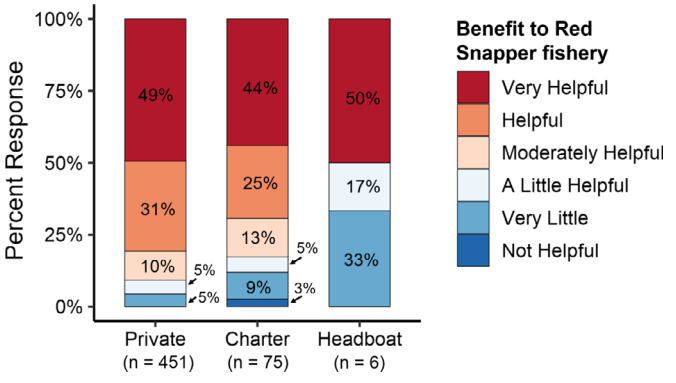

FIGURE 4. Percent response of private, charter, and headboat anglers when asked how helpful they believe descending devices would be in improving discard mortality in the Red Snapper fishery. The sample sizes listed under the stacked bars refer to the number of respondents from each recreational subsector.

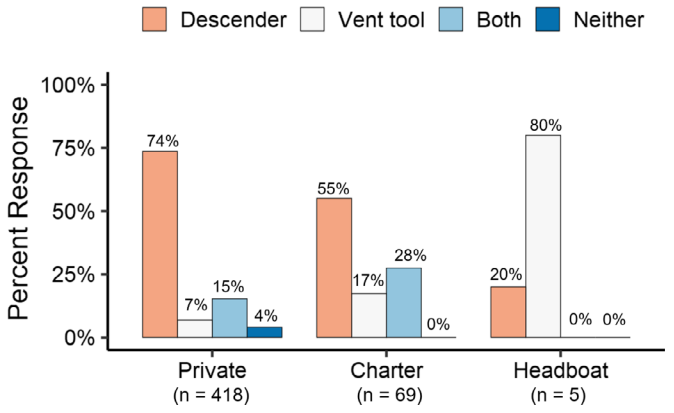

FIGURE 6. Percent response of private, charter, and headboat anglers when asked what barotrauma mitigation method they prefer after testing their SeaQualizer. Sample sizes correspond to the number of respondents from each recreational subsector.

preferred neither venting nor descending at the end of the study period.

Of the original 538 survey participants, 476 agreed to complete the secondary portion of the survey assessing fishing habits and demographic information. Fifty-four percent of respondents had been fishing for more than 20 years, 20% for 11 to 20 years, 17% for 5 to 10 years, 9% for 1 to 4 years, and only two respondents had been fishing for less than 1 year (0.4%). Charter captains were more likely to have greater fishing experience than private anglers (OLR: $\beta = 0.862$, $\chi = 10.404$, $P < 0.001$). When asked how many days they targeted reef fish last year, 41% took more than 20 trips, 24% took 11–20 trips, and the remaining 34% took 10 trips or less, with charter respondents having fished more days than private angler respondents (OLR: $\beta = 2.349$, $\chi = 50.219$, $P < 0.001$).

The majority of survey participants were males (96%) between the ages of 41 and 65 (66%). The highest level of education for 58% of respondents was a bachelor's degree or higher, and 66% held a combined household income of at least $75,000. Compared to charter captains, private anglers were more likely to have earned a higher education (OLR: $\beta = -1.192$, $\chi = 21.824$, $P < 0.001$) and hold a higher household income (OLR: $\beta = -0.559$, $\chi = 5.190$, $P = 0.025$). Education was not a significant predictor of either angler willingness to use descending devices (LRT: $P = 0.243$) or of perceived benefit of the devices to reduce discard mortality in the Red Snapper fishery (LRT: $P = 0.123$). Fishing experience was also not a significant predictor of angler willingness to use descending devices (LRT: $P = 0.090$) nor of the perceived benefit of the devices to reduce discard mortality (LRT: $P = 0.991$).

DISCUSSION

This study surveyed the perceptions, opinions, and attitudes of recreational anglers regarding the use of descending devices to reduce discard mortality in offshore reef fish. The majority of survey participants had positive perspectives on the benefits associated with using the tools to release discarded fish experiencing barotrauma. Slight differences in opinions existed between the three subsectors of the recreational fishing sector regarding their utility, but the majority believed they were effective tools for improving survival of discarded fish. Headboat respondents were less likely to use the devices due to the time-consuming process required to release a single discard while meeting client demands, although the low sample size ($n = 6$) for this fishing sector necessarily made this observation only qualitative. Nevertheless, all subsectors perceived descending devices to be beneficial tools in improving discard mortality in the Red Snapper fishery and more respondents preferred using fish descending devices to venting practices after the opportunity to use these devices. These results provide evidence that recreational anglers positively perceive and are willing to use fish descending devices to improve discard survival.

Descending devices offer anglers an alternative release strategy to invasive venting techniques. While studies have shown that both venting and rapid recompression can reduce mortality (Eberts and Somers 2017), rapid recompression does not require anglers to possess knowledge regarding fish anatomy and physiology, whereas venting does. In this way, descending devices can prevent well-intentioned anglers unfamiliar with venting procedures from injuring fish. For example, Scyphers et al. (2013) and Hazell et al. (2016) discovered that a substantial number of venting-tool users were inserting their hypodermic needles in improper locations, potentially puncturing vital organs and reducing the chance of survival. Furthermore, angler experience was not correlated with knowledge of proper venting technique (Scyphers et al. 2013). These complications associated with improper venting technique and location are prevented by employing descending devices. Even when venting tools are operated correctly, descending strategies may result in greater chances of fish survival (Curtis et al. 2015).

Based on the questionnaire results, the majority of anglers surveyed in this study indicated positive attitudes toward, and desire to learn, successful release practices using descending devices. Despite charter respondents having more fishing experience and previous knowledge regarding rapid recompression devices, a greater proportion of private respondents preferred descending devices to venting after operating the SeaQualizer. Seventy percent of survey respondents stated that their barotrauma mitigation preference was descending by the end of the study, suggesting a transition towards favoring descending devices over venting tools as a preferred release method. Moreover, the perceived benefit of these devices to increase survival of discarded fish is very high and even greater than when using venting tools. However, each subsector of the recreational fishery has differing motives for using descending devices during fishing trips. For example, charter captains and deck hands aboard headboats have additional challenges and expectations of clients in providing a quality fishing trip that private recreational anglers do not, and these demands might influence their willingness to use these devices under certain circumstances. Private anglers may prefer to focus on proper release techniques because they are not required to tend to clients and assist numerous anglers at once. Charter captains and deckhands likely experience more time-sensitive situations in which multiple fish require release simultaneously, potentially resulting in their higher likelihood to continue employing venting strategies as the less time-consuming method. Private anglers made up the majority of survey responses, while headboats comprised a relatively small

portion; therefore, observations regarding the perceptions of headboat captains and deckhands should be interpreted cautiously and additional data collection for this sector is certainly needed. Further research and development of more efficient strategies to descend fish and how these can best be implemented on headboat charters with many anglers catching fish simultaneously would be extremely useful.

Despite existing variations in attitudes and feasibility in use between the subsectors, the majority of all anglers surveyed believed descending devices could be beneficial in reducing discard mortality in the fishery. This preference was in contrast with results obtained in other studies, where the majority of offshore recreational anglers preferred venting to descending (Hazell et al. 2016; Crandall et al. 2018). A key difference between this study and those above was that anglers in this study received a free SeaQualizer and information on best practices for use. These participants also were able to use a descending device in the field while making judgments on its efficacy and utility prior to taking the survey, whereas 32% of the anglers in Crandall et al. (2018) were not aware of the descending devices prior to survey completion. Moreover, 53% of respondents in Crandall et al. (2018) targeted fishing depths of less than 18 m (60 feet), where many reef fish may not require assistance submerging. Only 13% of Gulf of Mexico and South Atlantic anglers from this study targeted depths of less than 23 m (75 feet), and 71% preferred descending to venting after employing a SeaQualizer on their vessel for an average of 8 months. Prior to acquiring the SeaQualizer for this study, 88% had used a venting tool and, of those, 78% had vented all or most fish exhibiting barotrauma. After using the descending devices, 70% preferred descending to using a venting tool. These results indicate that anglers in our study may have changed their preference of barotrauma mitigation techniques from venting to descending after employing a descending device on their vessel.

Conversely, the receipt of the free SeaQualizer device and distribution of best practices materials could have played an influential role in promoting a positive perception and preference reported by anglers through the removal of purchasing barriers and priming respondents with preconceived benefits of these devices. The FishSmart best practices brochure distributed along with the descending devices states that recompression is the method of choice for returning barotrauma-afflicted fish to the water. It is possible that this information could potentially bias the angler's perception of these devices and, while this does not negate their response, it could have potentially inflated the positive response towards descending devices relative to venting tools by a small unknown percentage. Crandall et al. (2018) reported that one of the barriers to using descending devices was the expense in purchasing, as well as the lack of training or knowledge of devices and the extra time requirement. Thus, the removal of these barriers to use seems to be a critical component in facilitating the use of these descending devices that may be achieved through complementary promotional programs and increasing angler knowledge and awareness through dissemination of materials on best practices and device use.

Angler knowledge and perception are often overlooked when formulating hypotheses and methods to improve release mortality and, in many instances, angler opinion, observation, and participation can be highly useful in assisting with research, management, conservation, and sustainable use of fishery resources (Aswani and Hamilton 2004; Granek et al. 2008; Boudreau and Worm 2010; Brownscombe et al. 2017). For fishery management agencies seeking to implement future regulations that require the use of specific tools to reduce mortality in released reef fish, studies such as this are imperative for successful integration. Cooke and Schramm (2007) noted the importance of gathering and disseminating data on the utility and effectiveness of new regulations prior to enforcing them. If angler knowledge regarding the use of such devices is rudimentary or even nonexistent, appropriate dissemination of methodological instructions and best-use practices would be an essential complement to the actual devices before anglers could be expected to use them. Unlike other barotrauma mitigation techniques, descending devices offer anglers an easy-to-operate tool that does not require extensive knowledge on the physiology of various species, which likely contributed to the strong preference for descending over venting release strategies.

While our survey response rate of 50% is extremely high for these types of studies, it is important to note that the perceptions of survey respondents may not necessarily be representative of the entire angling population. One characteristic that indicates that the survey respondents may be more representative of more avid anglers is the number of fishing trips reported during the duration of the study. The average angler had completed 15 offshore fishing trips over 8 months, which is far above average for the typical offshore reef fish angler. Additional demographic data from supplementary questions also indicates that more avid anglers were the likely participants for this study. The lack of survey results from some states also indicates that participation may be more positively influenced through better outreach and engagement channels. Future studies should seek to promote these outreach mechanisms and fill participation data gaps in order to obtain the most representative view of how descending devices are perceived in the entire recreational fishing community. Nevertheless, this study provides one of the most comprehensive collections of survey data on the perceptions of descender device use for the recreational fishery.

Overall, both charter and private recreational reef fish anglers were found to have positive perspectives and attitudes towards descending devices for improving release survival in fish exhibiting barotrauma. Moreover, 70% of survey respondents indicated a preference of descending over venting by the study's end after the opportunity to test these devices. Despite requiring more time and effort to deploy a descending device, recreational anglers perceived their benefit to outweigh the time saved by venting. Headboat operators were less likely to employ the devices due to the extra time requirement to operate them; however, most believed the devices would be successful in reducing discard mortality. These data provide managers with essential information regarding the opinions of fishery stakeholders towards improving discard mortality using rapid recompression techniques. Rapid recompression gives anglers perceived confidence that their discards will survive to be captured again in the future, and they are receptive to employing descending devices in the recreational reef fish fishery to increase survival of discarded fish.

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Appendix: Survey Questionnaire

*1. Are you (check only one):

- Charter boat captain/owner/operator
- Head boat captain/owner/operator
- Private recreational angler

*2. Did you receive your SeaQualizer:

- Directly from a dockside interviewer
- Via registration on the web
- From state agency personnel (other than dockside)
- Other (please specify)

*3. From which state do you most often fish saltwater (choose only one):

- AL
- FL
- GA
- LA
- MS
- NC
- SC
- TX

*4. What material do you remember receiving or viewing when you registered for or received your device? (select all that apply)

- FishSmart Best Practices flyer/brochure
- "How to Use a SeaQualizer" video
- FishSmart Video
- I didn't receive or view any materials

Other (please specify)

*5. Which of the following cues do you use on the water to decide when to use a descending tool or venting tool to release a fish (check all that apply):

- Fish appears bloated (inflated with air), but otherwise normal
- Stomach is protruding from mouth
- Eyes are bulging
- Fish appears sluggish or unresponsive when brought to the boat
- Fish is floating and unable to submerge
- I use a venting or descending tool on every fish, even if they exhibit none of the symptoms above
- I never use a venting tool or descending tool
- Other (please describe)

*6. Have you ever used a venting tool in the past?

- Yes
- No
- I don't know what this is

*7. Why don't you use a venting tool (check all that apply)?

- I don't think it works
- It is too time consuming
- Fish are able to swim down without venting
- Other (please specify)

8. What percentage of fish do you believe survive the **venting** process? (Use slider bar to adjust percentage)

0 – 100 percent

*9. How much knowledge did you have about **descender** devices in general before acquiring your SeaQualizer?

- None
- Very little
- Little
- Moderate
- High
- Very high

*10. Considering your normal fishing activity, how likely are you to use a descender device to release fish when needed?

- I would likely use it on all fish
- I would likely use it on most fish
- I would likely use it about half the time
- I would likely use it on very few fish
- I would not likely use it at all

*11. How helpful do you believe descender devices would be in reducing discard mortality in the Red Snapper fishery?

- Not helpful
- Very little
- A little helpful
- Moderately helpful
- Helpful
- Very helpful

12. What percent of fish do you estimate survive long-term after being released with a descender device (use slider bar to a djust percentages)?

0 – 100 percent

*13. When fishing for reef fish, what is your most common targeted fishing depth?

- Less than 75 feet
- 76-125 feet
- 126-175 feet
- 176-225 feet
- 226-275 feet
- Greater than 275 feet

*14. How many months have you had the SeaQualizer supplied as part of this program? (Use slider bar to indicate months)

0 (less than 1 month) 20 months

*15. On approximately how many trips did you use your SeaQualizer?

0 trips 100 or more trips

*16. Approximately how many fish have you released using the SeaQualizer?

	Red Snapper	Other Fish
None	None Red Snapper	None Other Fish
1-5 fish	1-5 fish Red Snapper	1-5 fish Other Fish
6-15 fish	6-15 fish Red Snapper	6-15 fish Other Fish
16-30 fish	16-30 fish Red Snapper	16-30 fish Other Fish
31-50 fish	31-50 fish Red Snapper	31-50 fish Other Fish
51-75 fish	51-75 fish Red Snapper	51-75 fish Other Fish
More than 75 fish	More than 75 fish Red Snapper	More than 75 fish Other Fish
I have no idea	I have no idea Red Snapper	I have no idea Other Fish

*17. After trying out the device, which release tool do you prefer to use for fish exhibiting barotrauma?

- Descending tool
- Venting tool
- Neither
- Both

*18. many other people have you talked with about descender devices or have you involved in the use of your SeaQualizer?

	None	1-5	6-10	11-15	More than 15
Other Fisherman	Other Fisherman None	Other Fisherman 1-5	Other Fisherman 6-10	Other Fisherman 11-15	Other Fisherman More than 15
Customers (charter or head boat)	Customers (charter or head boat) None	Customers (charter or head boat) 1-5	Customers (charter or head boat) 6-10	Customers (charter or head boat) 11-15	Customers (charter or head boat) More than 15
Non-Fisherman	Non-Fisherman None	Non-Fisherman 1-5	Non-Fisherman 6-10	Non-Fisherman 11-15	Non-Fisherman More than 15

*19. Part 1 is complete and you can choose to enter a drawing to win a Shimano Talica 16II two-speed lever drag reel, or a Shimano Terez extra heavy fast action 6'6" rod.

Would you be willing to answer a few more questions for a chance to win a Shimano Talica 25II two-speed lever drag reel,or a Shimano Tallus roller stripper tip medium heavy fast action 5'9" rod ?

- Yes
- No thanks

*20. How many years have you been fishing for reef fish?

- Less than 1 year
- 1 - 4
- 5 - 10
- 11 - 20
- More than 20

*21. How many days did you fish for reef fish in the last year?

- 0
- 1-5
- 6-10
- 11-20
- More than 20

*22. What distance from shore do you most often fish when fishing for reef fish?

- 0-10 miles
- 11-20 miles
- 21-30 miles
- 31-40 miles
- 41-50 miles
- 51-60 miles
- 61-80 miles
- More than 80 miles

The following questions are for statistical purposes only and will not be associated with your name or any other personally identifiable information.

*23. What is your 5-digit zip code?

*24. What is your gender?

- Male
- Female
- Would rather not say

*25. What is your highest level of education?

- Grammar School
- High School or equivalent
- Vocational or Technical School
- Bachelor's Degree
- dMaster's Degree
- Doctoral Degree
- Professional Degree (MD, JD, etc.)
- Would rather not say
- Other (please specify)

*23. What is your 5-digit zip code?

*24. What is your gender?

- Male
- Female
- Would rather not say

*25. What is your highest level of education?

- Grammar School
- High School or equivalent
- Vocational or Technical School
- Bachelor's Degree
- dMaster's Degree
- Doctoral Degree
- Professional Degree (MD, JD, etc.)
- Would rather not say
- Other (please specify)

*26. What is your age?

- 25 or under
- 26 - 40
- 41 - 55
- 56 - 65
- 66 or older
- Would rather not say

*26. What is your age?

- 25 or under
- 26 - 40
- 41 - 55
- 56 - 65
- 66 or older
- Would rather not say

*27. What is your current household income (include total income from all working members in the household)?

- Under $10,000
- $10,001 - $25,000
- $25,001 - $50,000
- $50,001 - $75,000
- $75,001 - $100,000
- $100,001 - $150,000
- More than $150,000
- Would rather not say

28. Do you have any comments or thoughts regarding your participation in this program or use of descending devices?

29. Thank you for completing this survey. To be eligible for either of the drawings, please provide your name and email below. **We must have an accurate email in order to contact you if you win!**

Please use the same email from which you received this survey link. Only one entry per individual or email address.

First Name

Last Name

30. Email Address:

Winners will be notified by March 1, 2017. Only one prize per person.