An evaluation of the effects of recreational catch and release angling on the survival of Gag grouper (*Mycteroperca microlepis*) with additional investigation into gear and strategies designed to reduce pressure related fishing trauma

Angela B. Collins* and Luiz R. Barbieri

Fish and Wildlife Research Institute, Florida Fish & Wildlife Conservation Commission
100 8th Avenue SE, St. Petersburg, FL 33701-5095

NOAA Award Number NA13NMF4330168
Award Period: September 1, 2013 – April 30, 2017

*Current address: University of Florida/IFAS Extension, Florida Sea Grant, Manatee County Government
1303 17th Street West, Palmetto, FL 34221. Email: abcollins@ufl.edu or angela.collins@myfwc.com

Final Report
FWC/FWRI File Code F4136-13-F
Submitted July 27, 2017

TABLE OF CONTENTS

Executive Summary

The Gag grouper (*Mycteroperca microlepis*) is a demersal epinephelid that occurs over hard bottom habitat in coastal and shelf waters of the Atlantic from Massachusetts to Brazil and throughout the Gulf of Mexico. This species supports extensive commercial and recreational fisheries, especially along the Gulf coast of Florida. Recent stock assessments update for Gag grouper suggest they are overfished in the Gulf of Mexico and current management restrictions for recreational anglers include size limits and increasingly shortened seasons. Whether or not such management strategies are effective depend upon whether they result in a significant reduction in fishing mortality. If catch continues to occur, and discard mortality is high, changes in regulations may have limited success.

Previous estimates of mortality due to catch and release have been based upon very short time intervals immediately post-capture or have been dependent upon recapture reports of dart-tagged fish. This study aimed to mimic recreational discard events and provide fine-scale data regarding fish survival after catch and release on the West Florida Shelf. Total monitoring periods and assessment of fish position within the water column provided evidence of survival at fishing depths to 40 m and allowed for a comparison of two barotrauma mitigation techniques (venting and weighted descent). The west Florida shelf is a center of abundance for Gag grouper, and the majority of recreationally harvested Gag grouper are landed along Florida's Gulf coast, making this area particularly relevant for this research.

Using a team of cooperative recreational anglers, 90 Gag grouper were caught and fitted with external pressure-sensitive acoustic tags. Fishing sites ranged in depth from 5 – 37 m, and Gag were caught on rod and reel by experienced reef fish anglers. Individuals were monitored for periods as great as 794 days post-release (mean = 144 days). Data indicate that release mortality is < 7% across the range of depths sampled. Barotrauma severity increased with fishing depth, but was not related to fishing season or total length of fish. With mitigation, barotrauma severity did not impact total monitoring period. Similarly, mitigation techniques had equivalent success with no significant differences noted among barotrauma treatment groups.

Gag grouper displayed relatively strong site fidelity, exhibiting daily presence at a single site for extended periods up to 550 days. Total monitoring periods were not significantly related to fish total length or to the season during which fish were caught. The majority of tagged Gag displayed daily presence at their tagging sites for weeks – months. Twenty-four percent of tagged gag were recaptured at some point during the study period. Recaptures ranged 0 – 794 days post-release. Recaptures of tagged gag that reported by commercial and recreational anglers demonstrated movements as far as 116 km away from tagging sites and as deep as 70 m. Recapture events demonstrated tag retention and provided further evidence of fish survival after catch and release and beyond acoustic monitoring periods.

During angling efforts for Gag, Gag and Red grouper (*Epinephelus morio*) dominated the catch (28% and 29% of total catch, respectively). American Red Snapper (*Lutjanus campechanus*) was the third most commonly encountered species (13% of total catch). In all, twenty eight species were encountered while fishing for Gag, and a total of 587 conventional identification dart tags were deployed on released fish (201 on Gag grouper, including acoustically tagged fish, and 386 on other reef fish species).

Research Purpose and Objectives

Identification of the problem

The Gag grouper (*Mycteroperca microlepis*) is a demersal epinephelid that occurs over hard bottom habitat in coastal and shelf waters of the Atlantic from Massachusetts to Brazil and throughout the Gulf of Mexico (Manooch and Haimovici 1978). This species supports extensive commercial and recreational fisheries, especially along the Gulf coast of Florida, where most Gag are landed (McErlean, 1963; Schirripa and Goodyear, 1994; SEDAR 2014).

The life history and biology of Gag grouper have been fairly well investigated (e.g., Bullock and Smith, 1991; Hood and Schlieder, 1992; Coleman et al., 1996; Collins et al., 1997; Brule et al., 2003; Fitzhugh et al., 2005; Lindberg et al., 2006; Lombardi-Carlson et al., 2006; Stallings et al., 2010). They are long-lived (to 31 years; Lombardi-Carlson et al., 2006), protogynous hermaphrodites that mature relatively late and aggregate to spawn. These life history characteristics contribute to the susceptibility of Gag to overexploitation, and research indicates that the species has undergone declines in abundance over the past several decades (Koenig et al., 1996; McGovern et al., 1998; Chapman et al., 1999).

After a planktonic larval phase, juvenile Gag settle in shallow, inshore areas and gradually move to deeper, offshore habitat with growth. Females are mature by the time they reach 585 mm total length (TL), and sexual transition occurs at approximately 1000 mm TL (Fitzhugh et al, 2006). Currently the legal size is 610 mm TL[1]; however, Gag grouper are aggressive predators and are regularly caught by recreational anglers at sublegal sizes. The recreational fishery is also managed by seasons, which vary according to stock assessments and current landings. Fish caught below the minimum size limit or out of season are returned to the water, and it has been estimated previously that recreational fishers discard over twice the amount of Gag grouper that they land (SEDAR 2006).

Recent stock assessments update for Gag grouper found that they are overfished in the Gulf of Mexico (SEDAR 2009, 2010, 2014). Management restrictions on harvest have significantly shortened the duration of the open season for recreational anglers. Season lengths vary each year, but current regulations require all Gag landed January through May to be released (myfwc.com). Whether or not such management strategies are effective depend upon whether they result in a significant reduction in fishing mortality. If catch continues to occur, and discard mortality is high, changes in regulations may have limited success.

Release mortality is significantly related to depth of capture, and will increase with depth (Burns et al., 2002; Ortiz 2006; Rudershausen et al., 2007). Ortiz (2006) estimated that recreational discards experience an average release mortality of 32%. More recent work by Sauls (2014) estimated discard mortality for the recreational Gag fishery in the Gulf of Mexico to range from <15% to 35.6%, with a linear increase in mortality as related to increasing depth of capture. Recreational release mortality is considerably lower than that estimated for the commercial Gag fishery (67%); however, due to the fact that the recreational sector accounts for a large portion of total Gag landings (60% in 2010; NMFS 2011), the release mortality associated with this sector

[1] Minimum size changed from 559 mm (22 inches) to 610 mm (24 inches) in February 2016. NMFS and FWC, 2016.

is an important variable during stock assessment and should be estimated with as much accuracy as possible.

Most estimates of mortality due to catch and release are based upon very short time intervals immediately post-capture (hours – days; e.g. Wilson and Burns, 1996; Overton and Zabawski, 2003; Butcher et al., 2009), or are dependent upon recapture reports of dart-tagged fish (e.g., Sumpton et al., 2010; Sauls 2014). Many of these experimental studies introduced confounding factors such as release into holding pens, longer fish handling times or extended intervals at the surface. While these studies provide valuable information, most quantify only immediate survival (hours – days) and may create higher levels of stress than those experienced during actual recreational discard events (Davis, 2002). Recapture reports often take many months, and many recaptures may go unreported. Uncertainty regarding the fate of fish that are not recaptured must also be considered. Acoustic telemetry offers a relatively non-invasive method of monitoring fish survival over longer time frames and allows researchers to more closely mimic the reality of a recreational discard event (Roberts et al., 2011).

Groupers are known to exhibit site fidelity (e.g., Beets and Hixon, 1994; Heinisch and Fable, 1999; Kiel, 2004; Lindberg et al., 2006). Lindberg et al. (2006) calculated mean residency times of almost 10 months for Gag grouper on artificial reefs in northwest Florida. Kiel (2004) estimated the home range of Gag to be less than 2000 m at the widest point, and reported that most individuals spent the majority of their time within an even smaller core area. Long residence times and relatively small home ranges make this species an ideal candidate for acoustic telemetry and allow for an assessment of not only acute, short term survival (hours – days) but also quantification of long term (weeks – months) survival and behavior.

Although extensive research on the life history and biology of this species has been conducted in the Gulf of Mexico (e.g. Hood and Schlieder, 1992; Collins et al., 1997; Brule et al., 2003; Fitzhugh et al., 2005; Lindberg et al., 2006; Stallings et al., 2010), minimal quantitative information is available regarding movement patterns and survival of Gag grouper after catch and release. Barotrauma is assumed to decrease survival of reef fishes after catch and release. Venting fish is a traditional method to mitigate barotrauma and can be used to return fish to depth. However, the effectiveness of venting has been questioned (Wilde, 2009), and success of this method may depend upon species, depth of capture, and angler experience. Alternative, less invasive methods exist (e.g., weighted descent) and are gaining popularity within the U.S. Comparing survival and behavior of individuals released via varying strategies designed to reduce the effects of barotrauma (venting vs. release by weighted line or crate) will provide quantitative information regarding the effectiveness of these techniques and inform future management guidelines.

Quantitatively assessing the effects of recreational catch and release angling for Gag grouper, in addition to continued investigation into movement patterns, stock structure and community composition, is invaluable information for future management and regulation of this species (Lucy and Studholme, 2002).

Project objectives

This project aimed to collaborate with recreational reef fish anglers on the west Florida shelf in order to address the following research topics:

- Quantify the survival and behavior of Gag grouper after a recreational catch and release event with respect to capture depth, season and fish size.

- Evaluate the effectiveness of mitigation strategies designed to reduce pressure related fishing trauma through a comparison of fish survival after venting or weighted descent.

- Characterize species composition and disposition of all reef fish caught during angling efforts for Gag grouper.

The west Florida shelf is a center of abundance for Gag grouper, and the majority of recreationally harvested Gag grouper are landed along Florida's Gulf coast (SEDAR 2014), making this area particularly relevant for this research.

Collaboration between a governmental agency and the recreational fishing sector made good sense for the study objectives, which were matched to management needs. Working with recreational captains was efficient and cost-effective because we were well-positioned with 1) a number of well-equipped vessels available as research platforms, 2) competent fishermen that provided realistic sampling and shared information regarding recreational angling practices for the target species, 3) an institutional memory for planning an efficient and effective sampling design, and 4) feedback from a dominant user group regarding this study's progress, results, and final conclusions.

Justification for government assistance

Pursuant to MARFIN research priorities, this proposal addressed topics relevant to rebuilding overfished marine fisheries, while involving the fishing industry. Specifically, and in order of relevance, the proposal best fit the following criteria defined within the 2012 FFO: [1.e. Characterize and assess the impact of bycatch of regulatory discards in recreational reef fish fisheries including depth-related release mortality for species caught with hook and line]; [1.g. Identify gear and tactics that can be used to return regulatory discards to depth in the recreational reef fish fisheries to minimize or reverse pressure-related fishing trauma.]; [2.a.6.a. Examine retention and residency of reef fish species]; [1.f. Characterize the species composition, size, and disposition of all fishes caught during recreational fishing (and) evaluate acute with chronic, long-term release survival rates]; [2.a.6.c. Conduct traditional tagging studies to estimate release mortality rates of reef fishes.]; [2.a.6.b. Conduct genetic research on stock structure of important reef fishes].

It is our hope that the results of this study are useful in future management of Gag grouper by NMFS, as well as the Florida Fish and Wildlife Conservation Commission, the Gulf of Mexico Fishery Management Council and any other management agencies charged with regulating harvest of this species.

Research Approach and Methods

Study area and site designation

Fishing sites were chosen in collaboration with cooperating recreational captains who served as research partners for the duration of this work. Sites included both natural and artificial reef habitats, and were chosen based upon depth and input from captains in an effort to be as representative as possible of the typical recreational Gag grouper fishery within the study area (Fig. 1). In order to assess the effects of capture depth and potential associated barotrauma, sites were distributed from 5 to 40 m, which encompasses the typical range of most recreational fishing effort for this species on the West Florida Shelf (10 – 90 km from shore; FWC, Fisheries-Dependent Monitoring Program, pers. comm.). Finally, sites were picked based upon relative proximity to each other in order to maximize the odds of detecting fish moving between sites.

Acoustic receiver deployment and array design

Acoustic receivers (Vemco VR2Ws) were deployed at all sites where Gag grouper were acoustically tagged. Acoustic receivers were positioned 25 – 100 m from the center of each site (Fig. 2). This placement was considered to be conservative, as these receivers have a listening radius of approximately 150 – 750 m depending upon environmental conditions (Pincock 2008). Prior to deployment, receivers were coated with a copper based antifouling paint to prevent biofouling and the associated reduction in detection capability (Heupel et al., 2008). All receivers were maintained and downloaded regularly for the duration of this research project.

Prior to the initiation of this research, detection tests were performed at six of the study sites across a range of depths (10 – 30 m) to ensure that receivers were placed properly for optimum detection of acoustic tags (> 90 % detection rate; McWhorter and Collins, 2011; Collins and Barbieri 2014). The habitat characteristics of the remaining sites were similar to those of detection test sites and receiver placement was conservative as stated above; therefore detection capacity and associated receiver positions throughout the array were assumed to be adequate for the study objectives.

Acoustic tagging of Gag grouper

Gag grouper were caught between December 2013 and February 2017 using rod and reel fitted with 8-0 or 9-0 hooks baited with live or dead bait. Anglers were avid recreational offshore fishermen who were instructed to fish "normally, as if a scientist were not on board." Upon landing, hook position, fish length (TL and SL, mm) and fish weight (kg) were recorded. Fish were inspected visually and the level of barotrauma (BT) was assigned a qualitative value of 0, 1, 2 or 3, where (0): minimal with no external signs of trauma and descent occurred immediately and independently upon release without mitigation; (1): moderate, with signs of gas bladder expansion (bloated body cavity, stomach eversion into buccal cavity; mitigation required for descent); (2): severe, stomach eversion is obvious and extended outside of the buccal cavity, and (3): extreme, stomach eversion extends outside of the buccal cavity, distended anus and/or exophthalmia.

All caught and released Gag grouper were fitted with a conventional identification (ID) tag (Hallprint PDL plastic tipped dart tags). Conventional ID tags displayed a unique ID number and the FWC tagging hotline phone number to facilitate angler reports of recaptured fish. Depending on total length, Gag grouper were fitted with either a V9 (Gag TL<600 mm TL; Vemco V9P-2x 69kHz, est. battery life 337 days) or V13 (Gag TL >600 mm TL; V13P-1x 69kHz, estimated battery life = 570 d) pressure sensitive acoustic transmitter. Transmitters were attached on the same side of the animal as the conventional ID tag (Fig. 3). A pressure sensor within the acoustic tag allowed for the transmission of depth data every 30 – 180 seconds. Depth data provided confirmation of fish movement after release and allowed fish position within the water column to be recorded for the duration of time that the fish was within the listening range of the acoustic receiver.

In order to mimic recreational catch and release as closely as possible, transmitters were attached externally. Although there was some concern about tag retention, external attachment allowed researchers to limit handling time and avoid the additional fish stress and recovery associated with surgery and internal implantation of transmitters. Transmitters were anchored securely beneath the dorsal fin rays using an umbrella dart (© Michael Domeier). Prior to deployment, transmitters were sprayed with clear antifouling paint (AquaGard Alumi-Koat, Flexdel Corporation, Lakewood, NJ, USA) to discourage invertebrate and algal growth. Fin clips for genetic analyses were taken from a portion of individuals and submitted for processing to the FWC/FWRI genetics lab.

Barotrauma mitigation

Current regulations encourage barotrauma mitigation for reef fishes suffering from pressure-related trauma after being brought up from depth to the surface. Venting (puncturing the swim bladder to release gas) has been the traditional suggested practice in Florida and venting tools were required equipment on board any vessel that landed reef fish species until 2014 (http://myfwc.com/fishing/saltwater/recreational/reef-fish-gear-rules/). However, the rule was repealed in 2014 in an attempt to provide anglers the ability to mitigate barotrauma using alternative methods. Weighted descent provides such an alternative and is gaining support and popularity among anglers across the globe. To assess differences in behavior and survival following different mitigation methods, released Gag were either vented by inserting a stainless steel hollow needle through the tissue behind the pectoral fin until it punctured the gas bladder or returned to the bottom using a weighted descending device (© Seaqualizer; Fig. 4). A portion of fish with no signs of barotrauma were also returned to the water with no mitigation at all.

An approximately equal number of fish were released via venting or weighted descent for all three depth zones (shallow, < 20 m; mid-depth, 20 – 30 m; and deep (>30 m). The effectiveness of each strategy was evaluated through acoustic telemetry, which provided continuous monitoring of fish position within the water column post-release. Total monitoring periods and associated survival could then be evaluated and compared among treatment groups.

Catch composition of other reef fishes

Species composition and disposition of all reef fish caught while fishing for Gag were recorded in order to provide information regarding the catch composition of reef fishes during angling efforts for Gag grouper. All caught fish were identified, measured for TL [or fork length (FL)] according to current management regime (i.e., if a species' size limit is enforced by fork length, FL was reported rather than TL). Whenever possible, released fish were fitted with a conventional identification tag in order to supplement recapture data as related to ongoing reef fisheries research along the west Florida shelf.

Data analysis and statistics

Acoustic data were analyzed to determine short-term survival after catch and release, to assess site fidelity and behavioral patterns of fish at each monitored site, and to describe movements within the study area. Duplicate and spurious detections were removed from the data prior to analysis. Acute survival and subsequent behavior after catch and release were monitored by assessing fish movement within the water column, as indicated by depth data transmitted every 30 – 180 seconds. Total monitoring period (TMP) for each individual was calculated as the number of days between tagging and the last valid detection recorded or verified recapture reported. Residence indices were calculated for fish at their tagging site (RI_{TS} = total days detected at tagging site/TMP) to identify residence times and site fidelity to a specific site.

The relationship between barotrauma severity and site depth, Gag TL, and TMP were compared using the Kruskal-Wallis One-Way ANOVA. This test was also used to compare TMP to Gag size class (both by 100 mm size bins and by sublegal/legal), season of tagging and barotrauma mitigation method.

General rates of movement (ROM) were calculated for fish that moved between sites within short intervals (<24 hours). When fish were observed to move between sites within 24 hours, the ROM was calculated by dividing the distance between sites by the travel time (the time between the last detection at one site and the first detection at another).

All statistical analyses were performed using either SigmaPlot 12.5 (Systat Software Inc., San Jose CA, USA) or SAS Enterprise (SAS Institute Inc., Cary NC USA).

Project management

All technical aspects of this project were managed by Angela B. Collins and Luiz R. Barbieri. Collins maintained communications with participating anglers, organized all of the necessary field work, analyzed data collected, and summarized research progress in required semi-annual reports to NOAA/NMFS. Barbieri oversaw the project through completion, performed quality control of research progress, and assisted with the interpretation and summarization of final results.

The project’s performance was monitored through semi-annual MARFIN reports, prepared by Collins and reviewed by Barbieri, in accordance to NOAA/NMFS deadlines. Financial and administrative requirements were monitored for FWRI by Janine Morganstern, the FWRI Operations and Management Consultant Manager. Dan Foster operated as the NMFS technical monitor and provided valuable comments through regular progress report reviews for the duration of this research.

Research Results and General Findings

Acoustic tags (pingers) were deployed on 90 Gag grouper during all seasons in the central eastern Gulf of Mexico between December 17, 2013 and November 15, 2016 (Fig. 5). Acoustic tagging locations included 18 of the 30 acoustically monitored sites within the study array (Table 1). An additional six pingers were deployed in February, 2017, but other than fish condition at capture (hooking location and barotrauma severity), the monitoring data from these six fish are not included within this report.

Tagged individuals ranged in size from 443 – 803 mm TL (Table 2) and were grouped into size bins based on total length (<510 mm TL; 510 – 609 mm TL; 610 – 709 mm TL; ≥ 710 mm TL; Fig. 6). The majority of individuals were hooked in the mouth (n = 92), but a small number of fish swallowed the hook partially (throat/gut; n =1) or entirely (gut; n = 3) or (Table 2).

Monitoring data are presented herein for 88/90 acoustically tagged fish. One individual (pinger ID 10826, TL = 508 mm, BT = 2) did not relay a single data point after release, and this individual was assigned a total monitoring period of 0 days. The other individual (pinger ID 9650, TL = 542 mm, BT = 0) was never detected within the acoustic array; however, a recreational angler reported this fish to the FWC hotline as harvested 271 days after tagging, so survival after catch and release following the tagging event was verified and the fish was assigned a total monitoring period of 271 days.

For the remaining 88 acoustically tagged Gag grouper, the total number of detections per individual after the removal of duplicate and spurious detections ranged from 2 – 482,592 (mean = 31,995), with an average number of 229 detections per day (range 0 – 1,129 detections per day). Total monitoring periods, defined as the length of time between tagging and final valid detection or verified recapture, ranged 0 – 794 days (mean = 144 days). Total monitoring periods assessed through acoustic telemetry verify survival and indicate the length of time that the tagged fish was detected within the study array.

Barotrauma, behavior and short-term survival after catch and release

Severity of barotrauma increased with capture depth (Fig. 7; $p < 0.001$), but was not related to fish total length (Fig. 8; $p=0.367$) and did not impact total monitoring period (Fig. 9; $p=0.694$). There was no relationship between barotrauma severity and season of capture ($p=0.147$).

Fish behavior as indicated by depth position within the water column after release varied by individual and by site (Appendix 1). Several fish (n=6) provided no data during the first 48 hours but reappeared at their tagging site within one week. Fish that provided no data at all (n=1), displayed no vertical movement at any point after release (n=2), or had total monitoring periods <48 hours (n=3) were assumed to be immediate mortalities as related to the catch and release event (6/90; 6.7%; Fig. 10). The remaining 84 individuals (93.3%) continued to display evidence of vertical movement within the water column at their tagging site after 48 hours, and all but three of these (81/90, 90%) remained on-site and provided valid movement data for at least two weeks following the catch and release/tagging event. Eighty percent of all tagged Gag (72/90) remained on-site and provided valid movement data for at least one month post-release (Fig. 10).

Long-term monitoring periods and residence times

Total monitoring periods (TMP, the length of time between the first and last valid detection or verified recapture) ranged 0 – 794 days (mean = 144 d). Gag grouper displayed relatively strong site fidelity, exhibiting daily presence at a single site for extended periods up to 550 days (Fig.

11). Total monitoring periods were not significantly related to fish total length ($p = 0.982$; Fig. 12) or to the season during which fish were caught (Fig. 13a).

The total number of days for which individuals were positively detected at a monitored site (> 5 detections within 24 hours) ranged 0 – 550 days (mean = 108 d). Residence indices ($RI_{TS;}$ total days detected at tagging site/TMP) indicate the proportion of time a tagged individual was detected at the site of tagging and ranged 0.03 – 1.0 (mean = 0.79). RI_{TS} did not differ among tagging seasons ($p = 0.400$; Fig. 13b).

Barotrauma mitigation evaluation

To assess differences in survival after various barotrauma mitigation techniques, tagged Gag grouper were released via descending device (n=33) or venting (n=35). The remaining fish were returned to the water with no mitigation performed (n=22) (Fig. 14). The majority of fish returned to the water with no mitigation were handled that way because they had no obvious signs of barotrauma (BT = 0; 17/22; Fig. 14) and quickly descended on their own accord. The remaining five were assigned BT values > 0 but detached from the weighted descending device while still at the surface and descended on their own.

There were no significant differences in total monitoring periods between mitigation groups overall ($p = 0.331$; Kruskal-Wallis One Way ANOVA), or when compared by barotrauma severity or depth range of capture (Fig. 14).

Recaptures and movement of acoustically tagged individuals

Multiple individuals (22/90, 24.4%) were recaptured by the research team (n=7) or by private anglers (n=15), and two of these individuals were recaptured twice after their initial tagging (Table 3). Most detections of tagged Gag grouper occurred at the initial site of tagging (mean $RI_{TS} = 0.79$, range 0.03 – 1.0); however, nine individuals were recaptured elsewhere at distances ranging 0.26 – 116 km away (Table 3). Only one individual (pinger ID 10655) was detected by acoustic receivers at other sites within the study area (Fig. 15) and eight individuals had confirmed movements away from their tagging sites as indicated by recapture locations reported by anglers (Table 3, Fig. 15).

Recapture events demonstrated tag retention and provided further evidence of fish survival after catch and release and beyond acoustic monitoring periods.

Rates of movement

One Gag grouper (pinger 10655; 644 mm TL at tagging; Fig. 14) swam between acoustically monitored sites within a single day (< 24 hours). Data were examined to assess a general rate of movement (ROM). Since the direct path and behavior of an individual while travelling between sites was unknown, ROM was calculated based on the assumption that fish moved in a straight horizontal line and did not stop. Therefore the ROMs calculated herein are likely an underestimate of actual swimming speed. After 206 days at its tagging site, this fish swam 4.3 km in 121 minutes (on 7/9/15; 2.1 km/hr) and 3.2 km in 88 minutes (on 7/13/15; 2.2 km/hr).

Catch composition of reef species while targeting Gag grouper

All species caught while targeting Gag grouper were recorded for length, level of barotrauma, hooking position and release method. Released individuals were fitted with conventional dart tags. Gag and Red grouper (*Epinephelus morio*) dominated the catch (28% and 29% of total catch, respectively), and American Red Snapper (*Lutjanus campechanus*) was the third most commonly encountered species (13% of total catch). In all, twenty eight species were encountered while fishing for Gag, and a total of 587 conventional identification dart tags were deployed on released fish (201 on Gag grouper, 386 on other reef species; Table 4). To date, 98 recaptures of all fish tagged during this project have been reported (Table 4).

Evaluation and Discussion

The overall goals and objectives of this project were attained, without modification to the initial proposal. The only exception included a no-cost extension request that resulted from weather-related delays in field work and was necessary to maximize data collection from tags deployed in late 2016.

Gag grouper are an economically and ecologically important reef species, so this research should be useful not only to those involved with management and regulation of Gag in particular, but also to those with interests in the systems that Gag grouper inhabit. Although this project specifically targets Gag grouper, the catch composition and incidental tagging data provide additional information relevant to the management of multiple species within the reef fish complex.

Barotrauma and short-term survival after catch and release

Fishing sites where Gag grouper were caught and tagged ranged from 5 – 37 m within the study area on the West Florida Shelf (10 – 90 km from shore; Fig. 1). Gag were caught on rod and reel by experienced recreational reef fish anglers and were fitted with external acoustic tags in order to minimize handling time and mimic recreational catch and release as closely as possible. Telemetry data were evaluated in order to provide an assessment of immediate, acute survival (hours – days; Cooke et al., 2002).

Barotrauma severity increased with site depth. This was not unexpected, as multiple studies have demonstrated that pressure related fishing trauma increases with capture depth (e.g., Feathers and Knable, 1983; Gitschlag and Renauld, 1994; Arlinghaus et al., 2007; Jarvis and Lowe, 2008; Campbell et al., 2010; Collins 2014). Moderate and severe levels of barotrauma were observed in Gag grouper caught deeper than 25 m, and external signs of trauma included gas bladder expansion, stomach eversion and swollen anal openings. Exophthalmia was not observed for any Gag captured during this project and barotrauma severity was not related to season of capture or fish length.

Fish suffering from barotrauma were either vented until they could descend independently or were returned to the bottom using weighted descent. Pressure sensitive acoustic tags provided a depth data point every 30 – 180 seconds, and allowed for a detailed description of behavior immediately after catch and release. Most individuals remained relatively immobile for the first few hours following release, but almost all tagged Gag resumed vertical movement in the water column within 48 hours (93%). Ninety percent of tagged Gag remained on-site and were monitored for at least two weeks following the tagging event, and eighty percent of tagged individuals maintained presence at their site of tagging for over one month. These data demonstrate survival and indicate minimal acute or delayed mortality after catch and release at depths inside 40 m.

This is especially relevant for the recreational Gag grouper fishery in Florida, since most Gag are landed on the west coast and the majority of recreational fishing efforts for this species on the west Florida shelf currently occurs at distances within 90 km from shore (SEDAR 2014; FWC Fisheries-Dependent Monitoring Program, pers. comm.). Although there are avid offshore reef fish anglers that will expend the effort to travel distances greater than 90 km from land, the majority of the recreational reef fish anglers on the west Florida shelf are likely fishing at shallower depths, so the data collected herein should be relatively indicative of recreational efforts within the study region.

Long-term monitoring and residence times

Passive tracking can provide valuable information regarding site fidelity and behavior of fishes over extended time frames (months – years; e.g. Lowe et al., 2003; Heupel et al., 2003). Benthic reef fishes are often sedentary with restricted home ranges (Sale 1978, Topping et al. 2005; Bryars et al., 2012), and dtrong site fidelity has been noted repeatedly among groupers (e.g., *Epinephelus striatus*, Bardach 1958; *E. guttatus*, Shapiro et al., 1994; *Plectropomus leopardus*; Zeller 1997; *E. tauvina*, Kaunda-Arara and Rose, 2004; *E. marginatus*, Afonso et al., 2011), including Gag (Kiel 2004), making them excellent candidates for acoustic telemetry.

The acoustic tags utilized during this project had estimated battery lives from 330 (V9P) to 570 days (V13P), and Gag were monitored within the acoustic array for periods as long as 550 days. Additional data provided through recapture reports extended total monitoring periods 794 days. Tracking work performed on Gag grouper to date has utilized both conventional dart tags (e.g., Beaumarriage, 1969; McGovern et al. 2005; Sauls 2014) and acoustic tags (Kiel, 2004; Lindberg et al., 2006; Biesinger 2013). These projects have provided information on long distance movements through tag-recapture as well as detailed data on fine-scale behavioral patterns at specific sites. Lindberg et al. (2006) estimated the average residency of Gag grouper to a specific reef to be about 10 months, which is slightly longer than the average residence periods observed in this study (mean = 108 days). However, most of the individuals tagged herein did display strong fidelity to a single site for weeks and some were detected almost daily for periods as long as 18 months at their initial site of tagging.

Total monitoring periods indicate the length of time that the fish was detected within the listening radius of an acoustic receiver within the study array and verify survival of the fish at least up to that final detection (or recapture). Disappearance from the study array is not necessarily indicative of fishing mortality and may be attributed to any of the following factors: 1) fish movement away from the site and outside of the range of deployed acoustic receivers, 2) tag loss or tag battery failure, or 3) predation or other natural mortality event.

Barotrauma mitigation

Venting has been identified as a procedure that can significantly reduce mortality in reef species (e.g., Feathers and Knable 1983; Wilson and Burns, 1996; Collins et al., 1999; Alos, 2008; Butcher et al., 2012). This practice is relatively simple, rapid and is commonly the preferred method for experienced reef fish anglers; however, it is an invasive procedure because it involves puncturing the fish's gas bladder and uninformed or unpracticed anglers may not always perform the procedure properly (e.g., misplaced needle punctures or not all gas is released). Additionally, venting still requires the fish to be released at the surface after which the released fish may suffer predation by other species (e.g., dolphin, barracuda, shark).

Alternatives to venting have become common practice in other regions (e.g., Australia) and these methods are gaining scientific support within the U.S. (e.g., Theberge and Parker, 2005; Rankin et al., 2017). Weighted descent allows a fish suffering from barotrauma to be taken to the bottom before being released from the weighted device, allowing for recompression and removing the need to vent. Weighted descent may also decrease the released fish's vulnerability to predation during descent and may especially increase survival in areas where there are high levels of predators such as dolphin, sharks or barracuda.

Total monitoring periods did not differ among barotrauma treatment groups, and both mitigation methods appear to have equal success in returning the fish to the bottom successfully. However, it should be noted that all venting was performed by experienced reef fish anglers. The survival of reef fishes that are vented by novices warrants further study. Recompression through weighted descent is a relatively fool-proof method of returning the fish to the reef and the data presented herein demonstrate that it is a valid and sustainable method for releasing Gag grouper suffering from pressure-related gas bladder expansion.

Recaptures and movements of tagged individuals

During this study, most Gag were detected at the same site for weeks – months. After the last detection at their tagging site, the whereabouts and destination of most tagged fish remain unknown, but several long distance movements were confirmed through recaptures or detections at other acoustically monitored sites within the study area. Two fish demonstrated distinct offshore movements, recaptured by commercial anglers at depths of 40 m and 70 m (116 and 111 km away from their respective tagging sites, 400 and 794 days after tagging, respectively).

McGovern et al (2005) reported that 23% of tagged Gag off the southeastern U.S. travelled distances > 185 km, and it is known that Gag grouper form spawning aggregations on the shelf edge in the Gulf of Mexico (). These data support previously published work that reported long-distance movements of Gag

Catch composition of reef species while angling for Gag grouper

Red and Gag grouper dominated the catch during angling efforts for this research. American Red Snapper was the third most commonly encountered species. These data may be relevant when projecting bycatch estimates of other species that may be regulated under different seasonal regimes (e.g., American Red Snapper constituted 13% of the total catch but is closed most of the year.)

Conclusions and need for additional work

Mortality due to catch and release is an important consideration during stock assessments and overall management of marine species (e.g., Bartholomew and Bohnsack 2005; Arlinghaus et al., 2007; Campbell et al., 2010). Species with high site fidelity and predictable movement or migration patterns are more vulnerable to fishing pressure (Polunin and Roberts 1996; Huntsman et al., 1999; Cheung et al., 2007), and large groupers especially present an interesting management challenge (Sadovy de Mitcheson et al., 2008) as many species form large spawning aggregations far from their typical residence (Gag, McGovern et al., 2005; Coleman et al., 2012; Nassau grouper *E. striatus*, Starr et al., 2007; squaretail grouper *Plectropomus areolatus*, Hutchinson and Rhodes 2010).

Telemetry data provided herein indicate that Gag grouper are not subject to high levels of release mortality in the eastern Gulf of Mexico at depths inside 40 m. Tagged Gag maintained residence at specific sites for weeks – months, and recaptures of individuals also demonstrated their capacity to move extensive distances within the region. Repeated recaptures of tagged Gag grouper after the initial tagging event further confirmed survival after catch and release events and identified that periodic interactions between this species and anglers within the study area are not uncommon. Although the repeat interval on the acoustic tags was not rapid enough to detect all recapture events, the telemetry data did reveal several fish that ascended from the bottom to the surface within 3 minutes, and these were confirmed as capture events through recapture reports to the FWC hotline or to A. Collins. Future research should incorporate acoustic tags on shorter intervals, which could demonstrate fishing removal rates or repeated catch and release of reef fishes at monitored sites.

Dissemination of Project Results

Results of the completed research should be of interest to others working on groupers, catch and release mortality, and reef systems in general. Throughout the duration of this project, a total of nine presentations were given during scientific meetings, state and federal management agencies, sport clubs, other stakeholder groups, or the general public. These presentations are listed below. We expect to continue to publish the findings of this research in the form of at least two manuscripts in peer-reviewed, scientific journals.

This work has been featured in the FWRI annual report (2014 – 2015) as well as online:

- http://flseagrant.ifas.ufl.edu/newsletter/tag/Gag-grouper/
- http://blogs.ifas.ufl.edu/manateeco/2015/09/17/reef-fish-return-to-the-deep/

Presentations to date

- Collins, A.B. and Barbieri, L.R. 2015. Discard Fate: Using Cooperative Research and Acoustic Telemetry to Assess Efficacy of Barotrauma Mitigation Techniques and Long-term Survival of Gag Grouper after Recreational Catch and Release. American Fisheries Society annual meeting. Portland, Oregon. August 16 – 21, 2015.
- Collins, A.B. 2015. Big fish tales: Tagging and tracking grouper after catch and release in the Gulf of Mexico. Jones Fish Pond School, Sarasota, FL. December 10, 2015.

- Collins, A.B. 2016. Discard fate: Using acoustic telemetry to assess long-term survival of Gag grouper after catch and release. Marine Fisheries Regulations Workshop, Naples, FL. January 19, 2016.
- Collins, A.B. 2016. Discard fate: Using acoustic telemetry to assess survival of reef fish after catch and release. Marine Fisheries Regulations Workshop. Sarasota, FL. April 5, 2016.
- Collins, A.B. 2016. Fish Tales and Technology: Surveys, Tags and Tools of the Trade. Invited guest speaker, University of South Florida Integrative Biology Department. Tampa, FL. April 22, 2016.
- Collins, A.B. 2016. Big Fish Tales: Cooperative Research in the Gulf of Mexico. Sarasota Scuba Club. Sarasota, FL. August 4, 2016.
- Collins, A.B., O'Hern, D. and McBride, R.S. 2016. Diving for Data, Fishing for Facts: Examples of cooperative research in the Gulf of Mexico. American Fisheries Society annual meeting, Kansas City, Missouri. August 18-23, 2016.
- Collins, A.B. 2016. Discard fate: Using acoustic telemetry to assess survival of reef fish after catch and release. Sarasota Bay Fisheries Forum. Sarasota, FL. October 13, 2016.
- Collins, A.B. 2017. Fish Tales and Technology: Surveys, Tags and Tools of the Trade. Invited guest speaker, Eckerd College. Saint Petersburg, FL. March 15, 2017.

Acknowledgements

Sincere gratitude is extended to the members of the Saint Petersburg Underwater Club, who assisted with the initial groundwork research that led to this project. We are especially thankful to Captains Ed Walker, Tommy Butler, John Fidi, Chris Taylor, Jimmy Levine and Keith Ludwig for guidance on fishing locations and for providing the crew and angling efforts required catch Gag for tagging. This work could not have been completed without the field efforts of Josh Taylor, Carlos Monzon-Aguirre and Jamie Williams who operated research vessels, coordinated crew and handled gear with ease. Keith Ludwig, Kyle McWhorter and Josh Taylor designed sturdy receiver anchors; Susan Lowerre-Barbieri shared data collected from two acoustic receivers deployed as part of another FWRI project. Thanks also to the many volunteer anglers and divers from multiple FWC-FWRI programs. We would also like to thank Dan Foster who served as the NOAA NMFS technical monitor during this work, and Robert Sadler, who monitored this project's progress through NMFS progress reports.

Literature Cited

Arlinghaus R, Cooke SJ, Lyman J, Policansky D, Schwab A, Suski C, Sutton SG and Thorstad EB. 2007. Understanding the Complexity of Catch-and-Release in Recreational Fishing: An Integrative Synthesis of Global Knowledge from Historical, Ethical, Social, and Biological Perspectives. Reviews in Fisheries Science 15: 75 – 167.

Beaumarriage, D.D. 1964. Returns from the 1963 Schlitz tagging program. Florida Board of Conservation Marine Laboratories Technical Series 43: 34 pp.

Beets, J. and Hixon, M.A. 1994. Distribution, persistence, and growth of grouper (Pisces: Serranidae) on artificial and natural patch reefs in the Virgin Islands. Bulletin of Marine Science 55: 470 – 483.

Biesinger, Z., Bolker, B.M., Marcinek, D. and Lindberg, W.J. 2013. Gag (*Mycteroperca microlepis*) space-use correlations with landscape structure and environmental conditions. Journal of Experimental Biology and Ecology 443: 1 – 11.

Bullock, L.H. and Smith, G.B. 1991. Seabasses (Pisces: Serranidae). Memoirs of the hourglass cruises: 8(2), 243 pp.

Burns, K.M., C.C. Koenig, and F.C. Coleman. 2002. Evaluation of multiple factors involved in the release mortality of undersized red grouper, Gag, red snapper, and vermilion snapper. Mote Marine Laboratory Technical Report No. 790.

Butcher, P. A., Broadhurst, M. K., Hall, K. C., Cullis, B. R., and Nicoll, R. G. 2010. Scale loss and mortality in angled-and-released eastern sea garfish (*Hyporhamphus australis*). ICES Journal of Marine Science 67: 522–529.

Brulé, T., Deniel, C., Colás-Marrufo, T., and Sanchez-Crespo, and Renán, X. 2003. Reproductive biology of Gag in the southern Gulf of Mexico. Journal of Fish Biology 63: 1505 – 1520.

Campbell MD, Patino R, Tolan J, Strauss R, and Diamond SL. 2010. Sublethal effects of catch-and-release fishing: measuring capture stress, fish impairment, and predation risk using a condition index. ICES Journal of Marine Science 67: 513–521.

Chapman, R.W., Sedberry, G. R., Koenig, C.C. and Eleby, B.M. 1999. Stock identification of Gag, *Mycteroperca microlepis,* along the southeast coast of the United States. Marine Biotechnology 1: 137 – 146.

Coleman, F.C., Koeing, C.C., and Collins, L.A. 1996. Reproductive styles of shallow-water groupers (Pisces:Serranidae) in the eastern Gulf of Mexico and the consequences of fishing spawning aggregations. Environmental Biology of Fishes 47: 129 – 141.

Coleman FC, Scanlon KM, Koenig CC. 2011. Groupers on the edge: shelf edge spawning habitat in and around marine reserves of the northeastern Gulf of Mexico. Professional Geographer 63, 1–19.

Collins, L. A., Johnson, A. G., Koenig, C. C., Baker, M. S., Jr. 1998. Reproductive patterns, sex ratio, and fecundity in Gag, *Mycteroperca microlepis* (Serrandiae), a protogynous grouper from the northeastern Gulf of Mexico. Fishery Bulletin 96: 415 – 427.

Collins, A.B. and Barbieri, L.R. 2010. Behavior, Habitat, and Abundance of the Goliath Grouper, *Epinephelus itajara*, in the Central Eastern Gulf of Mexico. NOAA/NMFS Final Report # NA07NMF4540085. 44 pp.

Collins, A.B. 2014. An investigation into the habitat, behavior and opportunistic feeding strategies of the protected Goliath grouper (Epinephelus itajara). PhD Dissertation, University of South Florida, Tampa, Florida.

Collins, A.B. and McBride, R.S. 2011. Demographics by depth: Spatially-explicit life history dynamics of a protogynous reef fish. Fishery Bulletin 109: 232 – 242.

Cooke, S.J., Schreer, J.F., Dunmall, K.M. and Philipp, D.P. 2002. Strategies for quantifying sub-lethal effects of marine catch and release angling: insights from novel freshwater applications. Pages 121 - 134 in J.A. Lucy and A. L. Studholme, eds. Catch and Release in Marine Recreational Fisheries. American Fisheries Society, Symposium 30, Bethesda, MD.

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

Feathers, M. G., and A. E. Knable. 1983. Effects of depressurization upon largemouth bass. N. Am. J. Fish. Manage. 3: 86–90.

Fitzhugh, G. R., Koenig, C. C., Coleman, F. C., Grimes, C. B., and Sturges, W. 2005. Spatial and temporal patterns in fertilization and settlement of young Gag (*Mycteroperca microlepis*) along the West Florida Shelf. Bulletin of Marine Science 77: 377 – 396.

Gitschlag GR, and Renaud ML. 1994. Field experiments on survival rates of caged and released red snapper. North American Journal of Fisheries Management 14: 131–136.

Hanson, C., Sauls, B., 2011. Status of recreational saltwater fishing in Florida: characterization of license sales, participation, and fishing effort. Am. Fish. Soc. Symp. 75, 355–365.

Heinisch, B.V. and Fable, Jr., W.A. 1999. Movement of Gag, *Mycteroperca microlepis*, in and from St. Andrew Bay, Florida. Bulletin of Marine Science 64: 501 – 508.

Heupel, M.R., Simpfendorfer, C.A. and Hueter, R.E. 2004. Estimation of shark home ranges using passive monitoring techniques. Environmental Biology of Fishes, 71: 135-142.

Hood, P. B. and Schlieder, R. A. 1992. Age, growth, and reporduction of Gag, *Mycteroperca microlepis* (Pisces: Serranidae), in the eastern Gulf of Mexico. Bulletin of Marine Science 51: 337 – 352.

Jarvis ET and Lowe CG. 2008. The effects of barotrauma on the catch-and-release survival of southern California nearshore and shelf rockfish (Scorpaenidae, Sebastes spp.). Canadian Journal of Fisheries and Aquatic Sciences 65: 1286 – 1296.

Kiel, B.L. 2004. Homing and spatial use of Gag grouper, *Mycteroperca microlepis*. Thesis, M.S. University of Florida. 89 pp.

Koenig C.C., Coleman, F.C., Collins, L.A., Sadovy, Y. and Colin, P.L. 1996. Reproduction in Gag (*Mycteroperca microlepis*) (Pisces: Serranidae) in the eastern Gulf of Mexico and the consequences of fishing spawning aggregations. *In*: Biology, Fisheries and Culture of Tropical Groupers and Snappers (Arreguín –Sánchez, F., Munro, J.L., Balgos, M.C. and Pauly, D., eds). ICLARM Conference Proceedings 48: 307 – 323.

Lindberg, W.J., Frazer, T.K., Portier, K.M., Vose, F., Loftin, J., Murie, D.J., Mason, D.M., Nagy, B. and Hart, M.K. 2006. Density-dependent habitat selection and performance by a large mobile reef fish. Ecological Applications 16: 731 – 746.

Lombardi-Carlson. L.A., G.R. Fitzhugh, B.A. Fable, M. Ortiz, C. Gardner. 2006. Age, length and growth of Gag from the NE Gulf of Mexico 1979-2005. NMFS Panama City Lab Contribution 06-03. SEDAR10 Data Workshop working paper 2 (SEDAR 10-DW2), 57 pp.

Lowe, C.G., Topping, D.T., Cartamil, D.P. and Papastamatiou, Y.P. 2003. Movement patterns, home range and habitat utilization of adult kelp bass Paralabrax clathratus in a temperate no-take marine reserve. Marine Ecology Progress Series, 256: 205-216.

Lucy, J.A. and Studholme, A.L., editors. 2002. Catch and release in marine recreational fisheries. American Fisheries Society, Symposium 30, Bethesda, MD.

Manooch, C. S. and Haimovici, M. 1978. Age and growth of the Gag Mycteroperca microlepis and size-age composition of the recreational catch off the southeastern United States. Transactions of the American Fisheries Society 107: 234 – 240.

McErlean, A.J. 1963. A study of the age and growth of the Gag, Mycteroperca microlepis Goode and Bean (Pisces: Serranidae), on the west coast of Florida. Florida Board of Conservation Marine Laboratory Tech. Ser. No. 41. 29 pp.

McGovern, J. C., Wyanski, D. M., Pashuk, O., Manooch, C. S. and Sedberry, G. R. 1998. Changes in the sex ratio and size at maturity of Gag, *Mycteroperca microlepis*, from the Atlantic coast of the southeastern United States during 1976-1995. Fishery Bulletin 96: 797 – 807.

McGovern, J.C., Sedberry, G.R., Meister, H.S., Westendorff, T.M., Wyanski, D.M. and Harris, P.J. 2005. A tag and recapture study of Gag, Mycteroperca microlepis, off the southeastern U.S. Bulletin of Marine Science 76: 47 – 59.

NMFS. 2011. Draft environmental assessment, regulatory impact review, and regulatory flexibility act analysis for a temporary rule to set the 2011 Gulf of Mexico Gag recreational and commercial management measures. Southeast Regional Office, 92 pp.

Ortiz, M. 2006. Preliminary status of Gag grouper in the Gulf of Mexico, SEDAR 10. Southeast Data Assessment and Review (SEDAR) Assessment Workshop (SEDAR-10 AW-02). 92 pp.

Overton, A.S. and Zabawski, J. 2003. Release mortality of undersized fish from the snapper/grouper complex off the North Carolina coast. NC Sea Grant 03-FEG-21.

Rankin, P.S., Hannah, R.W., Bloom, M.T.O., Miller-Morgan T.J., and Heidel, J.R. 2017. Delayed effects of capture-induced barotrauma on physical conditionand behavioral competency of recompressed yelloweye rockfish, *Sebastes ruberrimus.* Fisheries Research 186: 258 – 268.

Roberts, L. W., Butcher, P. A., Broadhurst, M. K., and Cullis, B. R. 2011. Using a multi-experimental approach to assess the fate of angled-and-released yellowtail kingfish (*Seriola lalandi*). ICES Journal of Marine Science 68: 67 – 75.

Rudershausen, P.J., Buckel, J.A. and Williams, E.H. 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.

Sadovy Y, Domeier M (2005) Are aggregation fisheries sustainable? Reef fish fisheries as a case study. Coral Reefs 24:254–262.

Sadovy Y, Eklund AM. 1999. Synopsis of the biological data on the Nassau grouper, Epinephelus striatus (Bloch 1972) and the jewfish, E. itajara (Lichtenstein 1822). U.S. Dep. Comm., NOAA Tech. Rep. NMFS 146, and FAO Fisheries Synopsis 157. 65 pp.

Sadovy de Mitcheson Y, Cornish A, Domeier M, Colin PL, Russell M, Lindeman KC. 2008. A global baseline for spawning aggregations of reef fishes. Conservation Biology 22:1233–1244.

Sadovy de Mitcheson Y, Craig MT, Bertoncini AA, Carpenter KE, Cheung WW, Choat JH, ... & Sanciangco J. 2013. Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. Fish and Fisheries 14: 119-136.

Sale PF. 1978. Coexistence of coral reef fishes – a lottery for living space. Environmental Biology of Fishes 3: 85 – 102.

Sauls, B. 2014. Relative survival of Gags *Mycteroperca microlepis* released within a recreational hook-and-line fishery: Application of the Cox Regression Model to control for heterogeneity in a large-scale mark-recapture study. Fisheries Research 105: 18 – 27.

Schirripa, M.J., and C.P. Goodyear. 1994. Status of Gag stocks of the Gulf of Mexico: Assessment 1.0. NOAA Fisheries Service, Southeast Fisheries Science Center, Miami Laboratory Contribution No. MIA 93/94-61.

Stallings, C. D., Coleman, F.C., Koenig C.C. and Markiewicz, D.A. 2010. Energy allocation in juveniles of a warm-temperate reef fish. Environmental Biology of Fishes 88: 389 – 398.

Sumpton, W.D., Brown, I.W., Mayer, D.G., McLennan, M.F., Mapleston, A., Butcher, A.R., Welch, D.J. et al. 2010. Assessing the effects of line capture and barotrauma relief procedures on post-release survival of key tropical reef fish species in Australia using recreational tagging clubs. Fisheries Management and Ecology 17: 77 – 88.

SEDAR. 2006. SEDAR 10 Stock Assessment Report: Gulf of Mexico Gag Grouper. Southeast Data, Assessment and Review Stock Assessment Report 2. 250 pp.

SEDAR. 2009. SEDAR Update Assessment of Gag in the Gulf of Mexico. Southeast Data Assessment and Review (SEDAR) report of assessment workshop. 171 pp.

SEDAR. 2010. Rerun of the SEDAR Update Assessment of Gag in the Gulf of Mexico. SouthEast Data Assessment and Review (SEDAR) report of assessment rerun. 33 pp.

SEDAR. 2014. SEDAR 33 – Gulf of Mexico Gag Stock Assessment Report. SEDAR, North Charleston SC. 609 pp.

Theberge, S.F., Parker, S.J., 2005. Release Methods for Rockfish. ORESU-G-05-001.Oregon Sea Grant Publications, Corvallis, USA.

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

Wilson, Jr., R.R. and Burns, K.M. 1996. Potential survival of released groupers caught deeper than 40 m based on shipboard and in-situ observations, and tag-recapture data. Bulletin of Marine Science 58: 234 – 247.

Tables and Figures

Table 1. Eighteen sites within the study array where Gag grouper were caught and fitted with acoustic tags. Column headings indicate site name, site depth, habitat type, number of Gag tagged on site, range and means of total monitoring periods (TMP days) for Gag tagged on site and range and means of residence indices (RI_{TS} = total days on site/TMP) for Gag tagged on site.

Site Name	Depth (m)	Habitat	Gag (n)	TMP days Range (mean)	Residence Index Range (mean)
EW5	5	Natural	6	15 – 400 (144)	0.09 - 0.94 (0.59)
EW1	13	Natural	10	17 – 201 (90)	0.12 – 0.93 (0.60)
ACJ	19	Natural	1	295	1.0
HRSL	19	Natural	4	0 – 266 (181)	0 – 0.99 (0.64)
TEN	19	Artificial	2	16 – 794 (405)	0 – 0.03
EW2	19	Natural	9	27 – 189 (93)	0.22 – 1.0 (0.78)
EW6	19	Natural	1	271	n/a
FIL	24	Natural	2	11 – 31 (21)	0.38 – 1.0 (0.69)
TB3	25	Natural	6	105 – 295 (209)	0.18 – 1.0 (0.86)
TB4	26	Natural	5	1 – 475 (217)	0.19 – 1.0 (0.83)
TB5	26	Natural	8	18 – 550 (191)	1.0 – 1.0 (1.0)
TB1	27	Natural	2	111 – 116 (114)	0.88 – 1.0 (0.94)
EW3	27	Natural	6	14 – 192 (107)	1.0 – 1.0 (1.0)
EW4	28	Artificial	8	10 – 191 (94)	0.36 – 1.0 (0.74)
TB2	29	Natural	4	0 – 280 (147)	0.22 – 0.87 (0.60)
TB8	33	Artificial	3	23 – 426 (227)	1.0 – 1.0 (1.0)
TB7	33	Natural&Artificial	7	1 – 297 (135)	0.86 – 1.0 (0.97)
TB9	37	Artificial	12	0 – 217 (83)	0.72 – 1.0 (0.91)

Table 2. Acoustically tagged Gag grouper *Mycteroperca microlepis*. Table headings indicate site name, depth, and habitat type; acoustic tag number (ID); total length (TL); barotrauma severity (BT); hook position; barotrauma mitigation release method (BT mitigation); tag date; date of last detection or verified recapture; total monitoring period (TMP); and total days detected at tagging site (DTS). Fish are grouped by tagging site in order of depth.

Site (depth, habitat type)	ID	TL (mm)	BT	Hook position	BT mitigation	Tag date	Last detection	TMP (days)	DTS (days)
EW5 (5 m, natural hard bottom)	10921	603	0	mouth	none	11/11/2015	05/08/16	179	120
	10919	646	0	mouth	none	11/11/2015	05/16/16	187	60
	10923	716	0	mouth	none	11/11/2015	11/30/15	19	18
	10920	744	0	mouth	none	11/11/2015	01/16/16	66	52
	10922	767	0	mouth	none	11/11/2015	12/15/16	400	37
	10927	696	0	mouth	none	4/19/2016	05/04/16	15	11
EW1 (13 m, natural hard bottom)	9646	542	0	mouth	none	12/17/2013	07/06/14	201	93
	9658	605	0	mouth	none	12/17/2013	07/03/14	198	126
	9665	557	0	mouth	Vent	3/15/2014	06/04/14	81	64
	9653	564	0	mouth	Vent	3/15/2014	04/01/14	17	2
	9654	566	0	mouth	Vent	3/15/2014	04/06/14	22	18
	9666	631	0	mouth	Vent	3/15/2014	05/09/14	55	47
	9656	514	0	mouth	none	4/22/2014	07/03/14	72	36
	9657	555	0	mouth	none	4/22/2014	07/29/14	98	61
	9674	618	0	mouth	none	4/22/2014	07/05/14	74	69
	9675	690	0	mouth	none	4/22/2014	07/09/14	78	20
ACJ (19 m, natural ledge)	10631	715	0	Gut	DD	6/24/2014	04/15/15	295	294
HRSL (19 m, natural ledge)	10643	778	1	mouth	DD	08/20/14	08/20/14	0	0
	10644	559	0	mouth	DD	12/16/14	08/23/15	250	160
	10655	644	0	mouth	Vent	12/16/14	07/13/15	209	206
	10828	542	0	mouth	none	09/03/15	05/26/16	266	250
TEN (19 m, artificial reef)	9667	771	1	mouth	Vent	04/02/14	06/04/16	794	27
	10825	480	2	mouth	DD	09/03/15	09/19/15	16	na
EW2 (19 m, natural ledge)	9647	546	0	mouth	none	12/17/13	04/22/14	126	92
	9659	584	0	mouth	none	12/17/13	01/13/14	27	27
	9652	561	0	mouth	Vent	03/15/14	05/23/14	69	67
	9662	600	0	mouth	Vent	03/15/14	08/17/14	155	143
	9664	603	0	mouth	Vent	03/15/14	05/29/14	75	21
	9663	660	0	mouth	Vent	03/15/14	05/30/14	76	76
	9655	600	0	mouth	none	04/22/14	06/18/14	57	56
	9672	623	0	mouth	DD	04/22/14	10/28/14	189	41
	9673	783	1	mouth	none	04/22/14	06/23/14	62	59
EW6 (19 m)	9650	542	0	mouth	Vent	03/15/14	12/11/14	271	na
FIL (24 m, natural ledge)	10632	750	1	mouth	DD	06/24/14	07/25/14	31	12
	10633	803	1	mouth	Vent	06/24/14	07/05/14	11	11
TB3 (25 m, natural ledge)	10635	589	2	mouth	Vent	07/22/14	05/13/15	295	289
	10639	597	1	mouth	DD	07/22/14	05/12/15	294	294
	10645	506	0	mouth	Vent	12/16/14	06/30/15	196	196
	2760	478	2	mouth	DD	11/15/16	04/29/17	165	164
	2759	520	1	mouth	DD	11/15/16	02/28/17	105	19
	2561	565	2	mouth	DD	11/15/16	06/02/17	199	196
TB4 (26 m, natural ledge)	10640	487	1	mouth	DD	07/22/14	04/10/15	262	262
	9678	694	1	mouth	Vent	07/22/14	11/09/15	475	91
	10641	573	2	mouth	Vent	08/20/14	08/21/14	1	1
	10661	657	0	mouth	Vent	12/16/14	01/21/15	36	36
	10660	767	0	mouth	DD	12/16/14	10/23/15	311	303

Table 2, cont'd. *Acoustically monitored Gag grouper, continued from previous page.*

Site name (site depth, habitat)	ID	TL (mm)	BT	Hook position	Release method	Tag date	Last detection	TMP (days)	DTS (days)
TB5 (26 m, Natural ledge)	9677	645	1	mouth	DD	07/22/14	01/23/16	550	550
	10658	712	0	mouth	Vent	12/16/14	05/28/15	163	163
	10657	732	1	mouth	DD	12/16/14	04/25/15	130	130
	10656	745	0	mouth	Vent	12/16/14	01/24/15	39	39
	10659	746	2	mouth	DD	12/16/14	08/30/15	257	257
	10827	528	2	mouth	DD	09/03/15	09/21/15	18	18
	2757	519	1	mouth	DD	11/15/16	05/10/17	176	176
	2758	519	1	mouth	DD	11/15/16	05/30/17	196	196
TB1 (27 m, Natural ledge)	10636	443	1	mouth	Vent	07/15/14	11/03/14	111	111
	10634	650	1	mouth	DD	07/15/14	11/08/14	116	103
EW3 (27 m, Natural ledge)	9649	473	1	mouth	none	02/04/14	08/15/14	192	192
	9648	568	2	mouth	none	02/04/14	08/14/14	191	191
	9668	703	0	mouth	DD	04/22/14	08/14/14	114	114
	10647	509	1	mouth	Vent	12/30/14	01/13/15	14	14
	10646	603	1	mouth	Vent	12/30/14	04/15/15	106	106
	10648	716	0	mouth	DD	12/30/14	01/21/15	22	22
EW4 (28 m, Artificial reef)	9651	494	2	mouth	Vent	02/04/14	05/05/14	90	90
	9660	626	1	mouth	none	02/04/14	08/14/14	191	143
	9661	648	2	mouth	Vent	02/04/14	06/24/14	140	103
	9671	604	1	mouth	DD	04/22/14	08/14/14	114	42
	9669	673	2	mouth	DD	04/22/14	05/02/14	10	7
	9670	704	2	mouth	DD	04/22/14	08/13/14	113	80
	10928	620	2	mouth	Vent	04/19/16	06/04/16	46	31
	10929	665	1	mouth	DD	04/19/16	06/04/16	46	46
TB2 (29 m, Natural edge)	10638	635	1	mouth	Vent	07/15/14	07/15/14	0	0
	9676	729	1	mouth	DD	07/15/14	10/02/14	79	18
	10637	747	1	mouth	Vent	07/15/14	04/21/15	280	192
	10642	583	1	mouth	none	10/29/14	06/15/15	229	200
TB8 (33 m, Artificial reef)	9681	654	2	mouth	Vent	11/12/14	07/01/15	231	231
	10653	703	1	mouth	Vent	11/12/14	01/12/16	426	426
	10652	734	1	mouth	DD	11/12/14	12/05/14	23	23
TB7 (33 m, Natural and artificial reef)	9679	710	2	mouth	DD	10/29/14	08/22/15	297	266
	10649	664	1	mouth	Vent	01/13/15	02/18/15	36	36
	10650	671	0	mouth	none	01/13/15	04/09/15	86	86
	10917	500	1	mouth	DD	06/23/15	01/04/16	195	195
	10916	758	1	mouth	Vent	06/23/15	09/13/15	82	82
	10918	780	0	gut	Vent	06/23/15	06/24/15	1	1
	10829	495	2	mouth	DD	10/12/15	06/14/16	246	212
TB9 (37 m, Artificial reef)	10654	722	2	mouth	DD	11/12/14	06/17/15	217	158
	10915	769	2	gut	DD	03/11/15	06/17/15	98	98
	10826	508	2	mouth	Vent	03/16/16	na	0	0
	10925	543	2	throat/gut	DD	03/16/16	03/25/16	9	9
	10924	571	1	mouth	Vent	03/16/16	06/20/16	96	85
	10926	583	2	mouth	Vent	03/16/16	06/02/16	78	74
	2762	463	1	mouth	Vent	02/03/17			
	2761	537	2	mouth	Vent	02/03/17			
	2763	567	1	mouth	DD	02/03/17			
	2564	590	1	mouth	Vent	02/03/17			
	2562	665	1	mouth	Vent	02/03/17			
	2563	672	2	mouth	DD	02/03/17			

Table 3. Tag/recapture data for acoustically tagged Gag grouper that have been recaptured since their initial tagging date (n = 22). Two individuals were recaptured twice. Days at large indicates number of days between initial tagging and recapture date († = harvested, otherwise the fish was released after recapture). Distance moved corresponds to straight line distance between site of tagging and location of recapture. Barotrauma severity at initial capture (0 = minimal, 1= moderate, 2= severe) and barotrauma mitigation release method at initial release (DD = weighted descent, V = Vent, and none = no action taken). Individual IDs correspond to the acoustic transmitter ID.

ID	Tagged	Recaptured	Days at large	Distance moved (km)	Barotrauma severity, release method
2561	11/15/16	06/02/17†	199	0	2, DD
9646	12/17/13	12/27/13	10	0	0, none
9650	03/15/14	12/11/14†	271	1.7	0,V, dropped on deck
9653	03/15/14	04/22/14	38	0	0, V, dropped on deck
9658	12/17/13	03/15/14 07/05/14†	88 200	0 2.2	0, none
9659	12/17/13	01/13/14	27	0	0, none
9660	02/04/14	04/22/14	77	0	1, none
9663	03/15/14	05/31/14†	77	3.2	0, V, dropped on deck
9667	04/02/14	06/04/16†	794	111	1, V
9674	04/22/14	07/05/14†	74	2.2	0, none, bleeding at tag
9681	11/12/14	03/11/15	119	0	2, V
10637	07/15/14	10/29/14	106	0	1, V
10640	07/22/14	08/20/14	29	0	1, DD
10650	01/13/15	04/09/15†	86	0.3	0, none
10825	09/03/15	09/19/15	16	0	2, DD
10919	11/11/15	11/11/15 05/16/16†	0 187	0 30.6	0, none
10922	11/11/15	12/15/16†	400	116	0, none
10923	11/11/15	11/30/15†	19	0	0, none
10927	04/19/16	11/08/16†	203	0	0, none
10928	04/19/16	06/04/16†	46	0	2, V
10929	04/19/16	06/04/16†	46	0	1, DD
9657	12/17/13	04/22/14	126	0	0, none

Table 4. Species composition of fish caught while fishing for Gag grouper over the course of the study period (December 2013 – February 2017). Length ranges and means are reported as either total length (TL) or fork length (FL), based on the length at which specific species size limits are regulated. *Not all caught fish could be tagged due to either fish size or staffing constraints during heavy landing periods.*

Species	Common name	Length range (TL or *FL, mm) [mean]	Tagged [Caught]	Recaptured [%]
Balistes capriscus	Gray triggerfish	*260 – 300 [280]	3 [3]	
Calamus proridens	Littlehead porgy	280 – 365 [321]	3 [8]	
Carcharhinus spp.	Reef shark	NM (> 1000)	0 [2]	
Centropristis striata	Black seabass	265	1 [1]	
Cephalopholis cruentata	Graysby	294	1 [1]	
Diplectrum formosum	Sand perch	260 – 300 [280]	0 [2]	
Epinephelus morio	Red grouper	206 – 720 [443]	231 [263]	45 [20%]
Euthynnus alletteratus	Little tunny	620	0 [1]	
Haemulon aurolineatum	Tomtate	225	0 [1]	
Haemulon plumierii	White grunt	225 – 392 [293]	7 [59]	
Holocentrus adscensionis	Squirrelfish	NM	0 [1]	
Lachnolaimus maximus	Hogfish	*289 – 470 [342]	5 [10]	
Lutjanus campechanus	American red snapper	295 – 703 [393]	40 [118]	3 [8%]
Lutjanus griseus	Gray snapper	268 – 584 [419]	15 [53]	4 [27%]
Lutjanus synagris	Lane snapper	178 – 418 [311]	3 [10]	
Mycteroperca microlepis	Gag grouper	355 – 824 [576]	201 [251]	44 [22%]
Mycteroperca phenax	Scamp	330 – 487 [400]	23 [31]	
Ocyurus chrysurus	Yellowtail snapper	305 – 370 [330]	4 [7]	
Rhizoprionodon terraenovae	Atlantic sharpnose shark	NM	0 [1]	
Rhomboplites aurorubens	Vermillion snapper	236 – 347 [301]	3 [9]	
Scianops ocellatus	Red drum	987	1 [1]	
Scomberomorus cavalla	King mackerel	*880 – 1000 [940]	2 [4]	
Scomberomorus maculatus	Spanish mackerel	*570 – 621 [596]	0 [2]	
Seriola dumerili	Greater amberjack	*306 – 977 [644]	41 [58]	1 [2%]
Seriola rivoliana	Almaco jack	*336 – 393 [365]	3 [3]	
Seriola zonata	Banded rudderfish	*384 – 610 [500]	0 [7]	
Sphyrna barracuda	Great Barracuda	NM (>1000)	0 [1]	
Synodus saurus	Lizardfish	454	0 [1]	

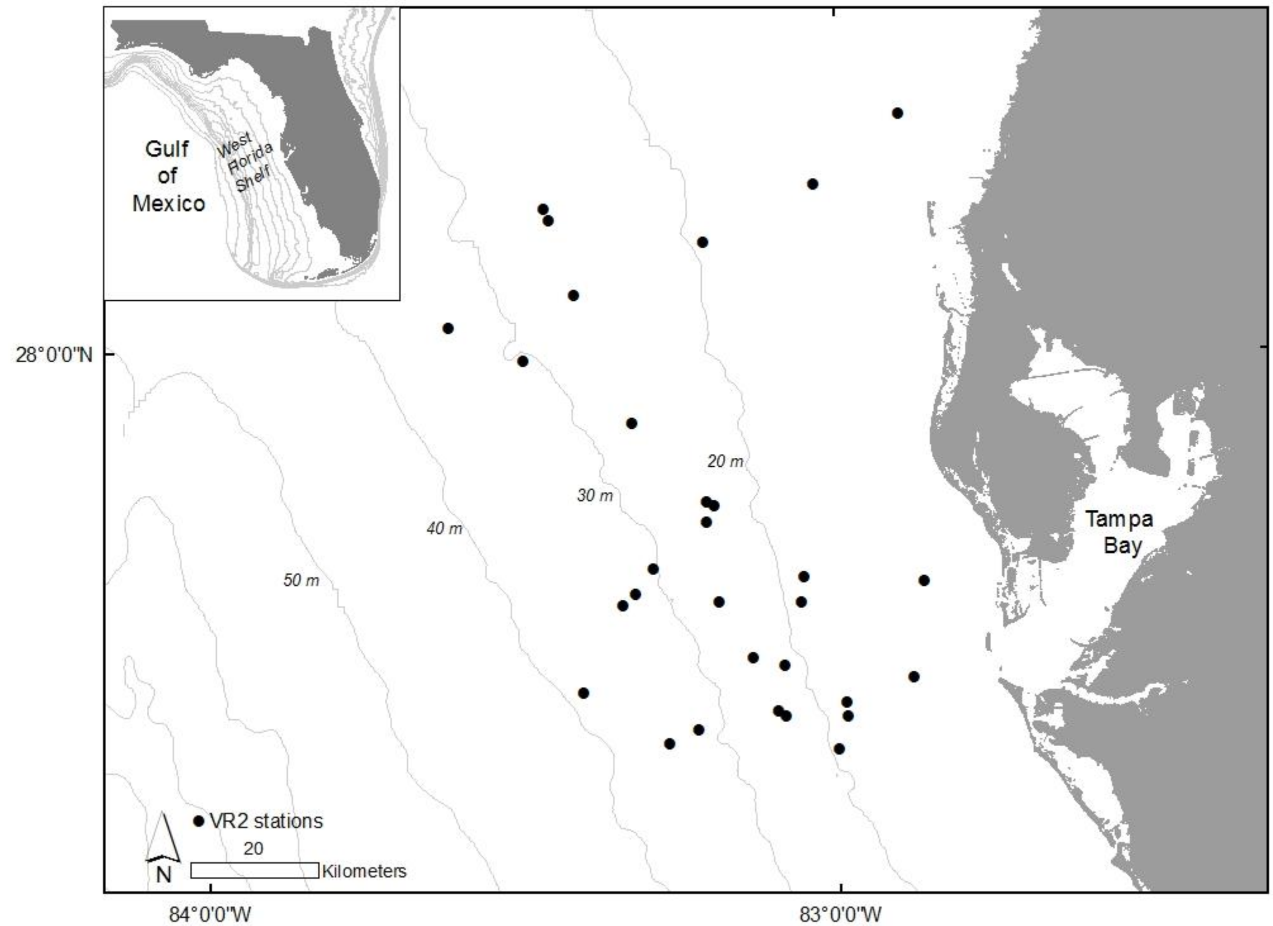


Fig. 1. Map of study area and sites where acoustic receivers were deployed (Vemco VR2Ws). Gag grouper fishing sites were chosen based on input from participating captains, and were distributed across the region in order to sample a range of depths and hard bottom habitats on the central West Florida Shelf.

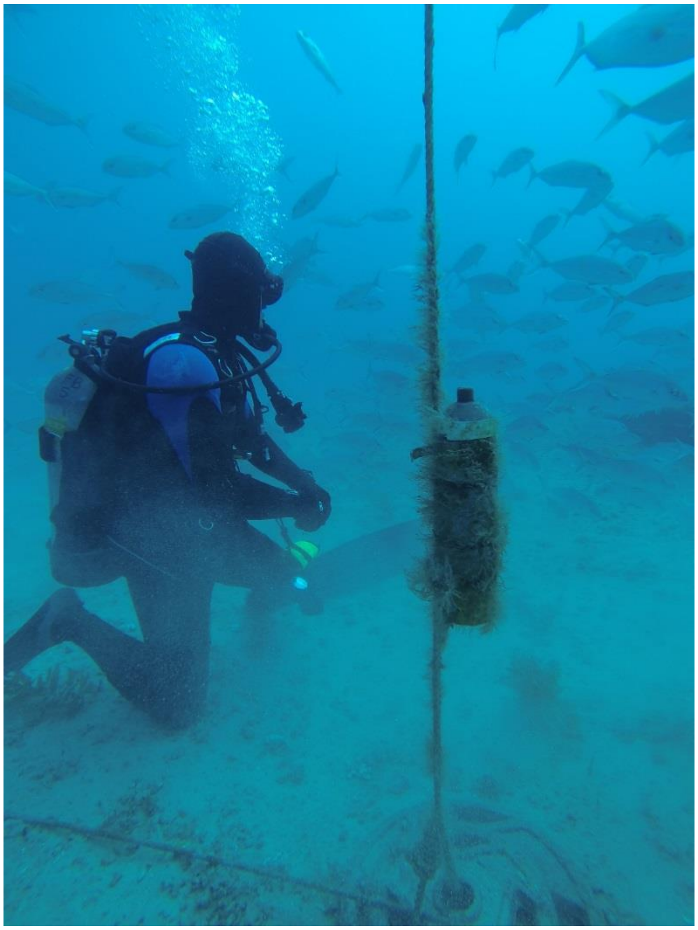


Fig. 2. A diver prepares to maintain an acoustic receiver (Vemco VR2W) anchored within the study array. Acoustic receivers were painted with antifoul paint and downloaded at least twice per year.

Fig. 3. Conventional identification tag (anterior) and acoustic transmitter (V13P; posterior) externally attached beneath the dorsal fin of Gag grouper *Mycteroperca microlepis* prior to release.

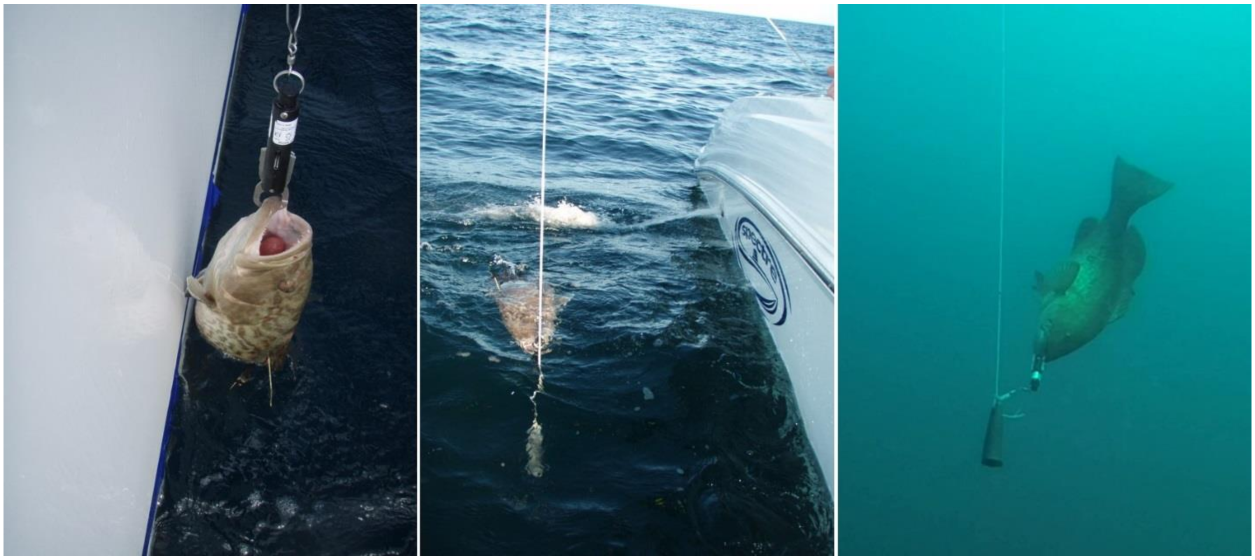


Fig. 4. Weighted descent of a Gag grouper after catch and release. Note everted stomach inside buccal cavity in the first panel. A weight attached to the dropline and descending device descended the fish to reef bottom, where the lip grip opened and released the fish. Weighted descent was used as an alternative to venting for a portion of acoustically tagged Gag grouper during this research project.

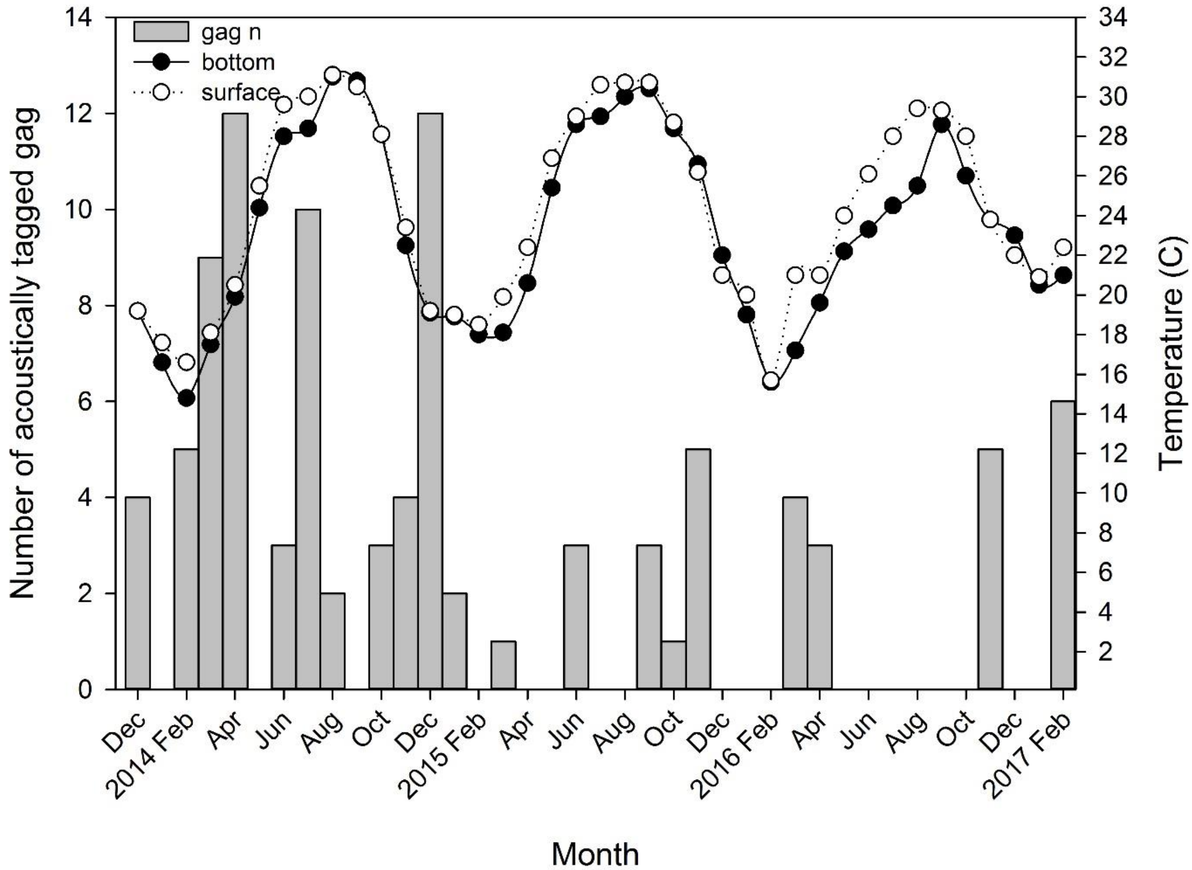


Fig. 5. Bars demonstrate the number of acoustically tagged Gag per month between November 2013 and February 2017 (total n = 96). Water temperatures for the surface (○) and bottom (●) of the water column within the study area for each month are displayed as averages from sites within the study array.

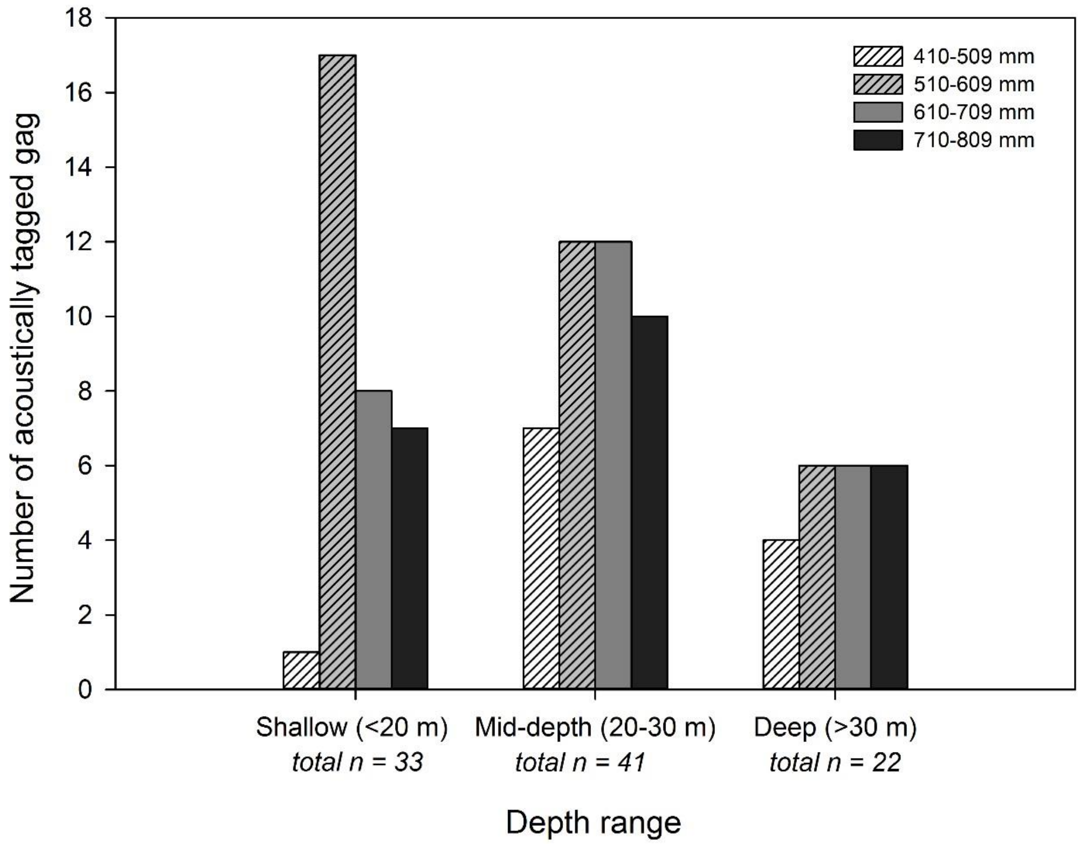


Fig. 6. Number of Gag grouper acoustically tagged within each depth range. Gag grouper were grouped by total length into 100 mm bins. Hatched bars indicate size classes that were sublegal size at the writing of this report [<610 mm (24 inches) TL].

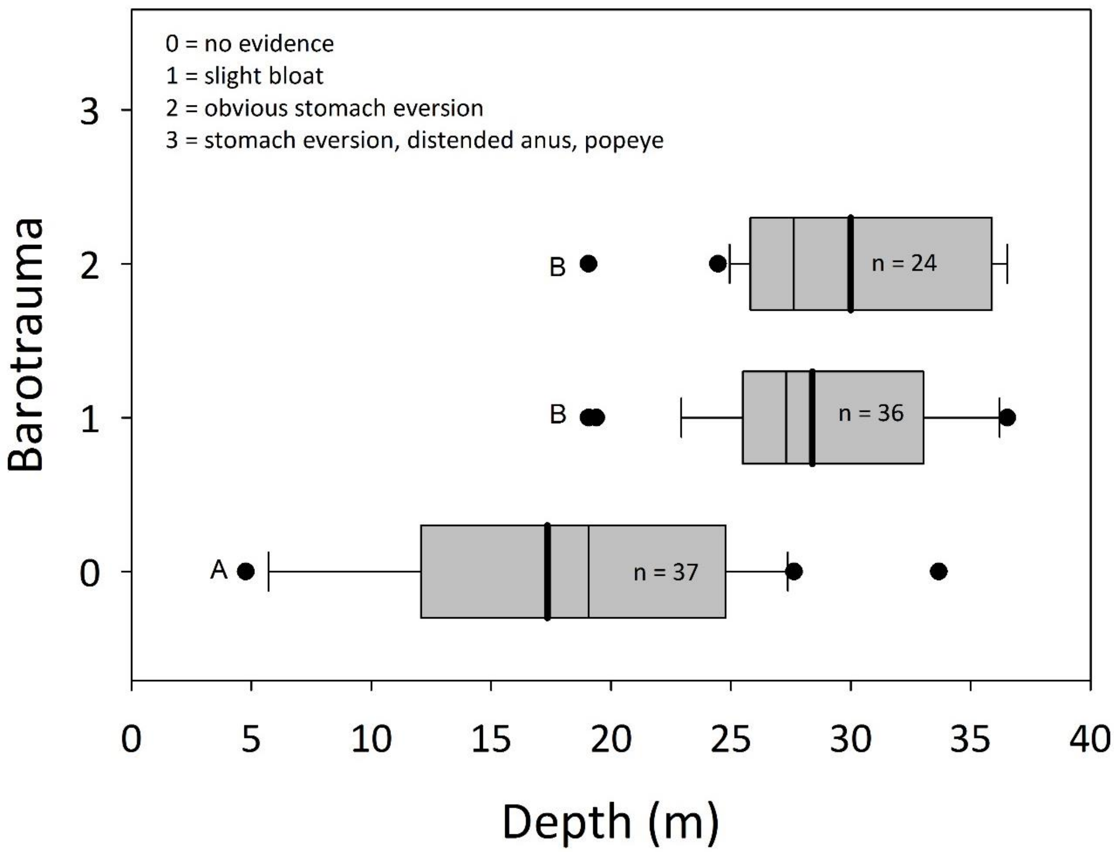


Fig. 7. Barotrauma (BT) values for Gag grouper, *Mycteroperca microlepis*, by depth of capture. BT values were assigned qualitatively after a visual inspection as minimal (0), moderate (1), severe (2) or extreme (3). There were no Gag that displayed extreme barotrauma (BT = 3) over the course of this study. Severity was significantly higher ($p < 0.001$; Kruskal-Wallis One Way Anova) at capture depths greater than 25 m. Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively. Letters denote significant differences between groups.

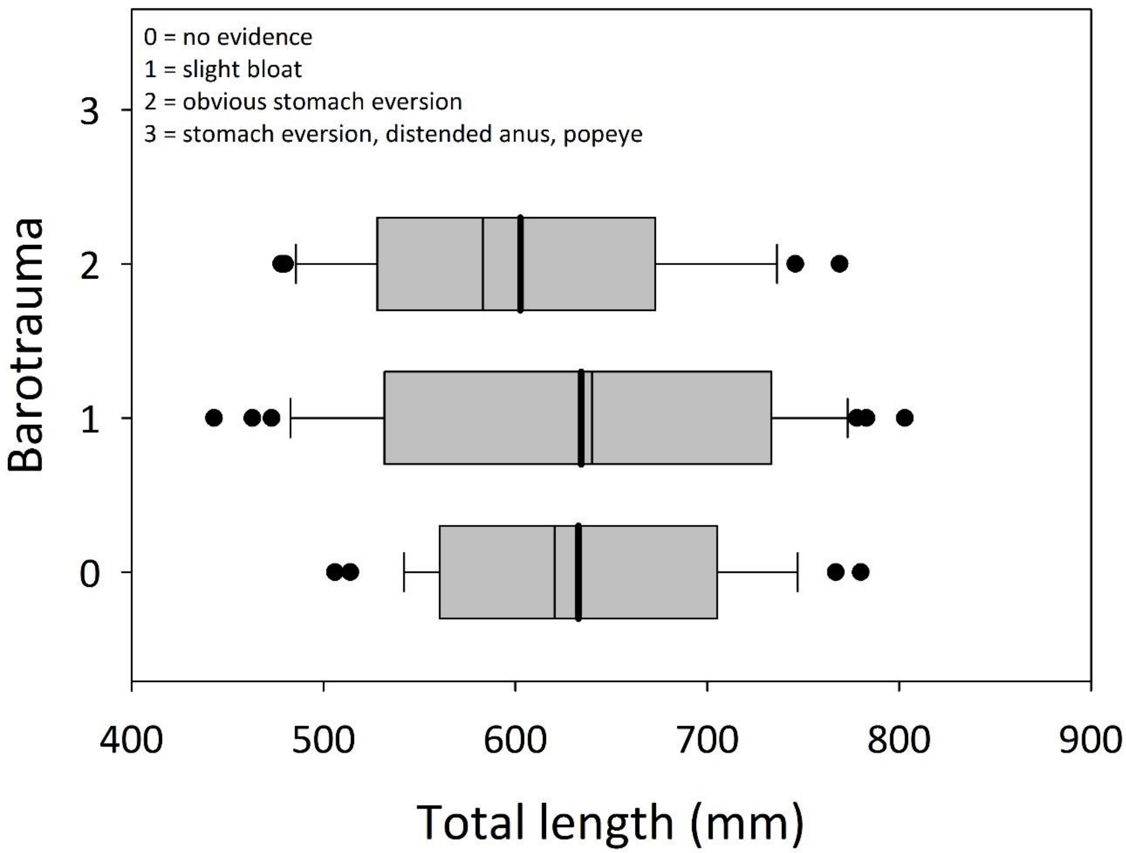


Fig. 8. Barotrauma (BT) values for Gag grouper, *Mycteroperca microlepis*, by total length. BT values were assigned qualitatively after a visual inspection as minimal (0), moderate (1), severe (2) or extreme (3). There were no Gag that displayed extreme barotrauma over the course of this study. Severity of barotrauma was not related to the total length of the fish ($p = 0.367$). Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively.

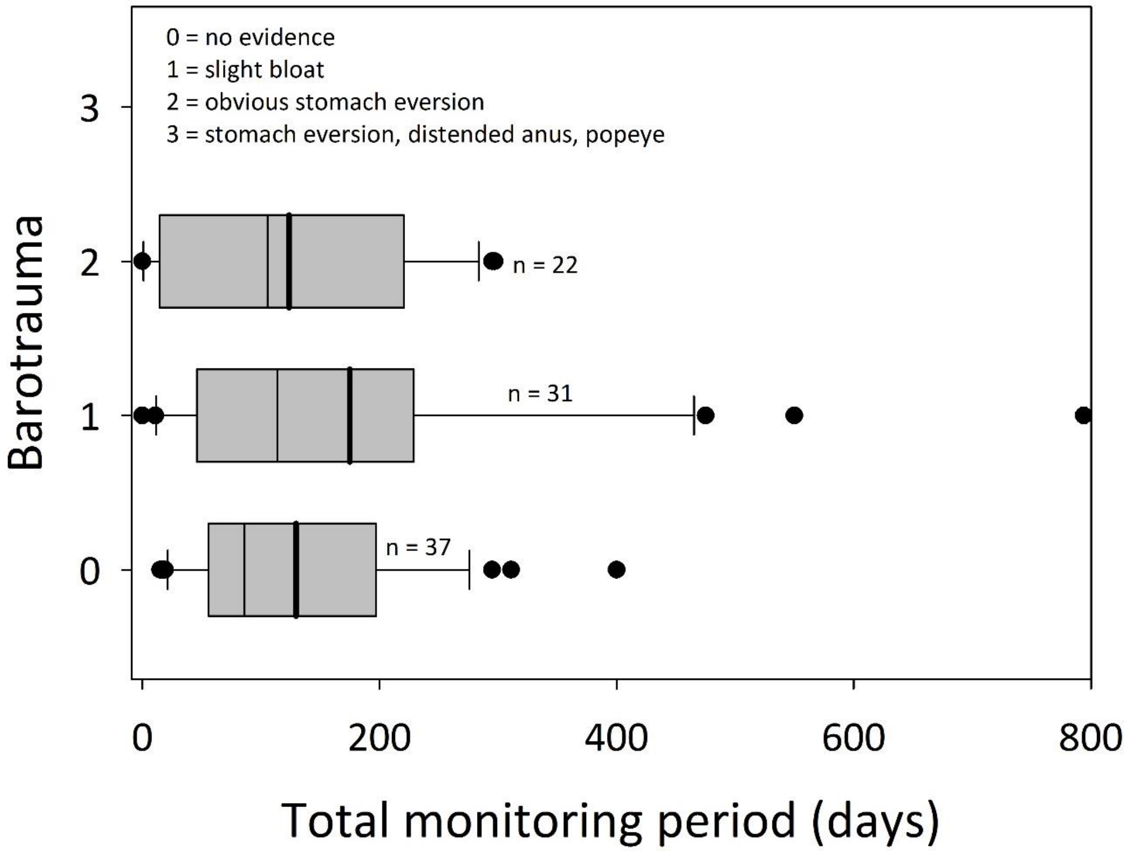


Fig. 9. Barotrauma (BT) values for Gag grouper, *Mycteroperca microlepis,* versus total monitoring period of tagged fish. There were no significant differences in monitoring period among barotrauma groups (p=0.694; Kruskal-Wallis One Way ANOVA) at capture depths greater than 25 m. Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively.

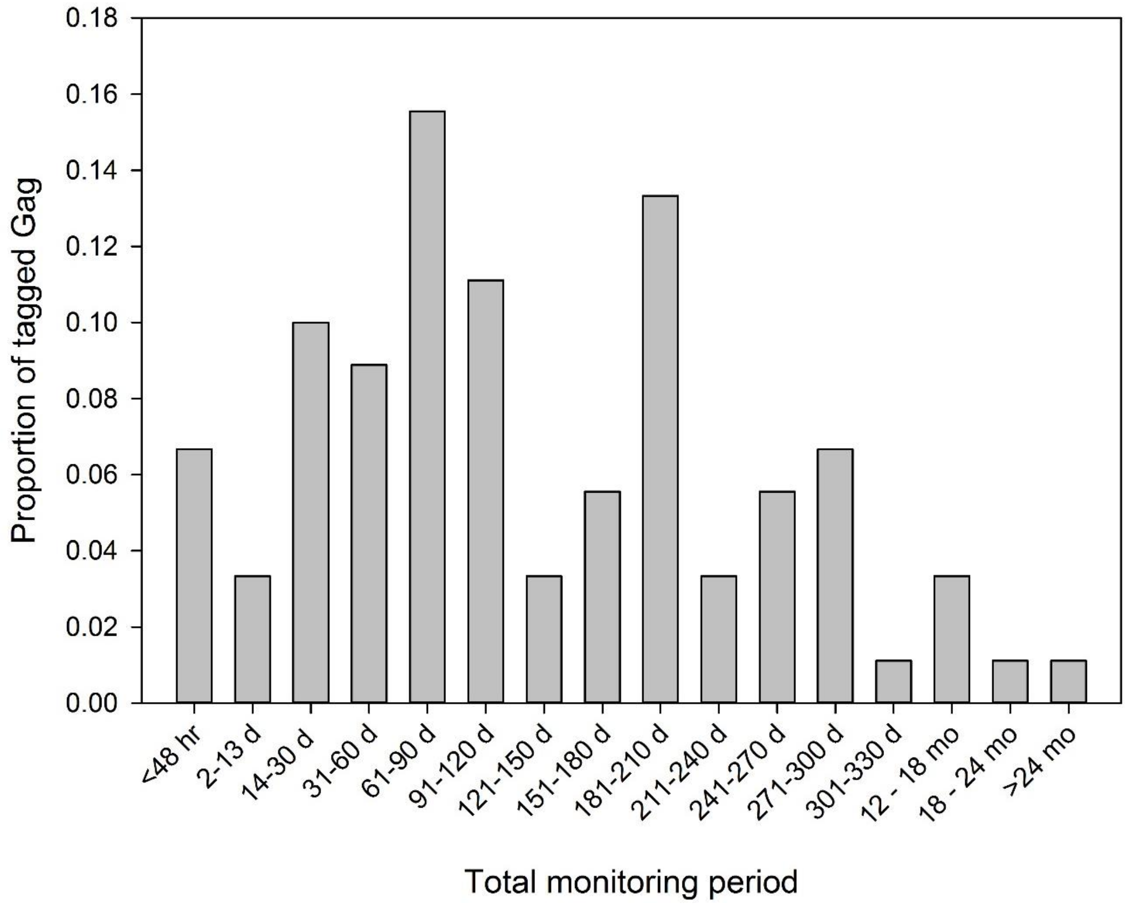


Fig. 10. Survival as indicated through acoustic monitoring of tagged Gag grouper after catch and release. Six out of 90 tagged individuals (7%) provided no evidence of vertical movement within the water column after the first 48 hours. The remaining 84 fish are grouped by the length of time for which valid monitoring data exist. Eighty percent of tagged individuals (72/90) remained within the range of the acoustic array for for at least one month after the catch and release event.

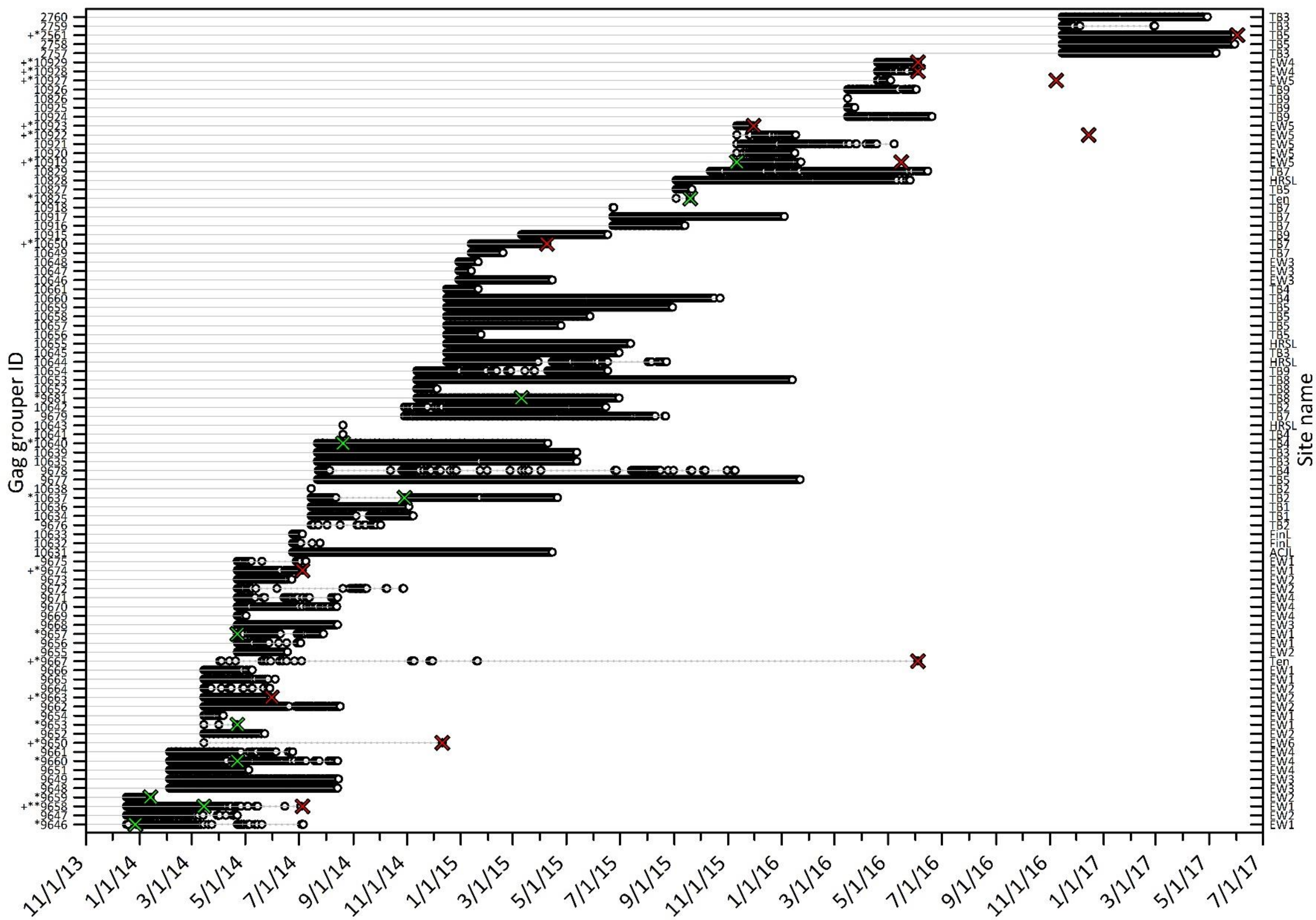


Fig. 11. Daily presence of acoustically tagged Gag (n=90) between December 2013 and July 2017. Gag grouper ID is displayed along the left y-axis, and tagging site is displayed along the right y- axis. Released and harvested recaptures of tagged individuals as reported by anglers are indicated by green and red ×s, respectively.

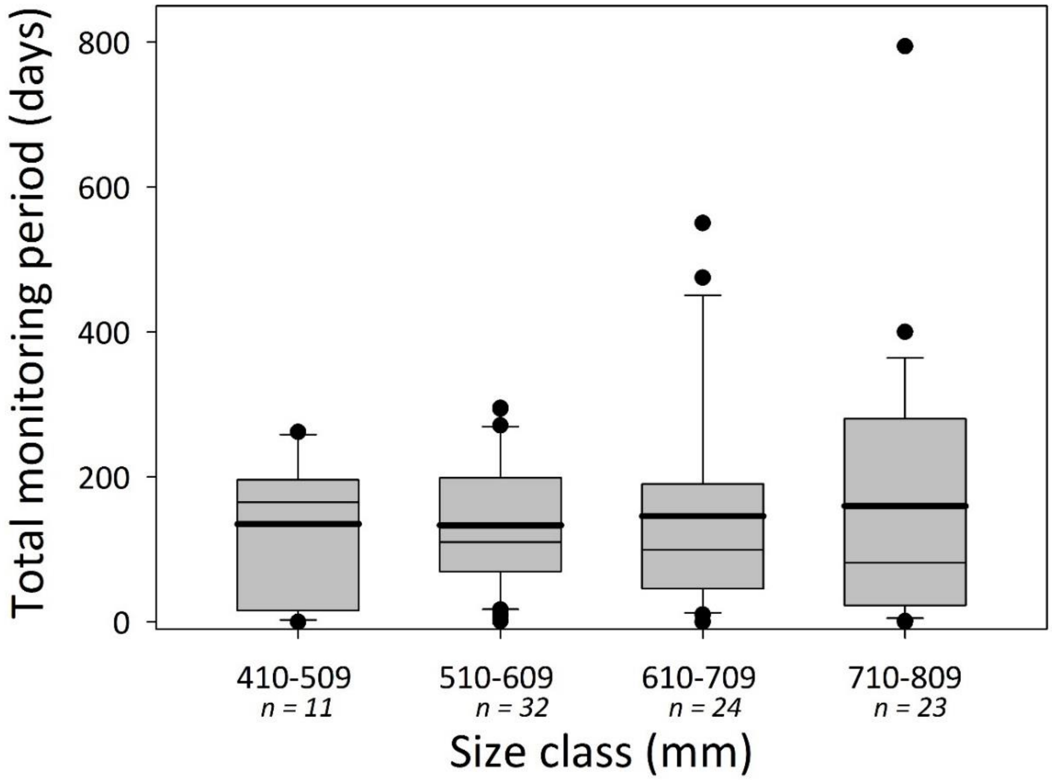


Fig.12. Total monitoring periods for each size class of acoustically tagged Gag grouper. Numbers of individuals tagged within each size class are indicated in italics along the x-axis. There were no significant differences in monitoring period among size classes (p=0.982; Kruskal-Wallis one way ANOVA) at capture depths greater than 25 m. Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively.

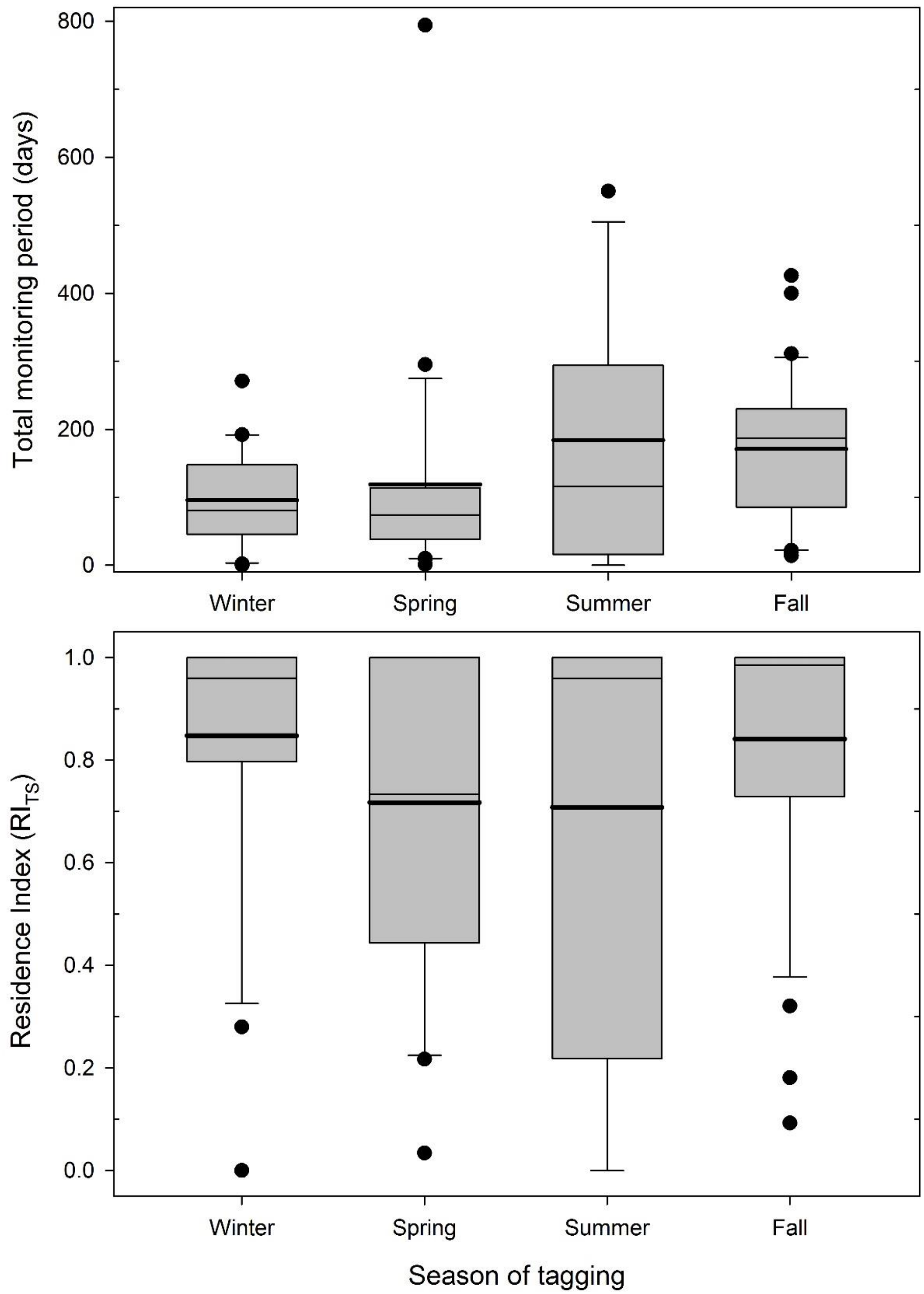


Fig 13. Total monitoring periods (top) and residence index (bottom) by season of tagging. Number of fish tagged within each season: winter (Jan – Mar; n = 21), spring (Apr – Jun; n = 21), summer (Jul – Sep; n = 15) and fall (Oct – Dec; n = 33). Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively.

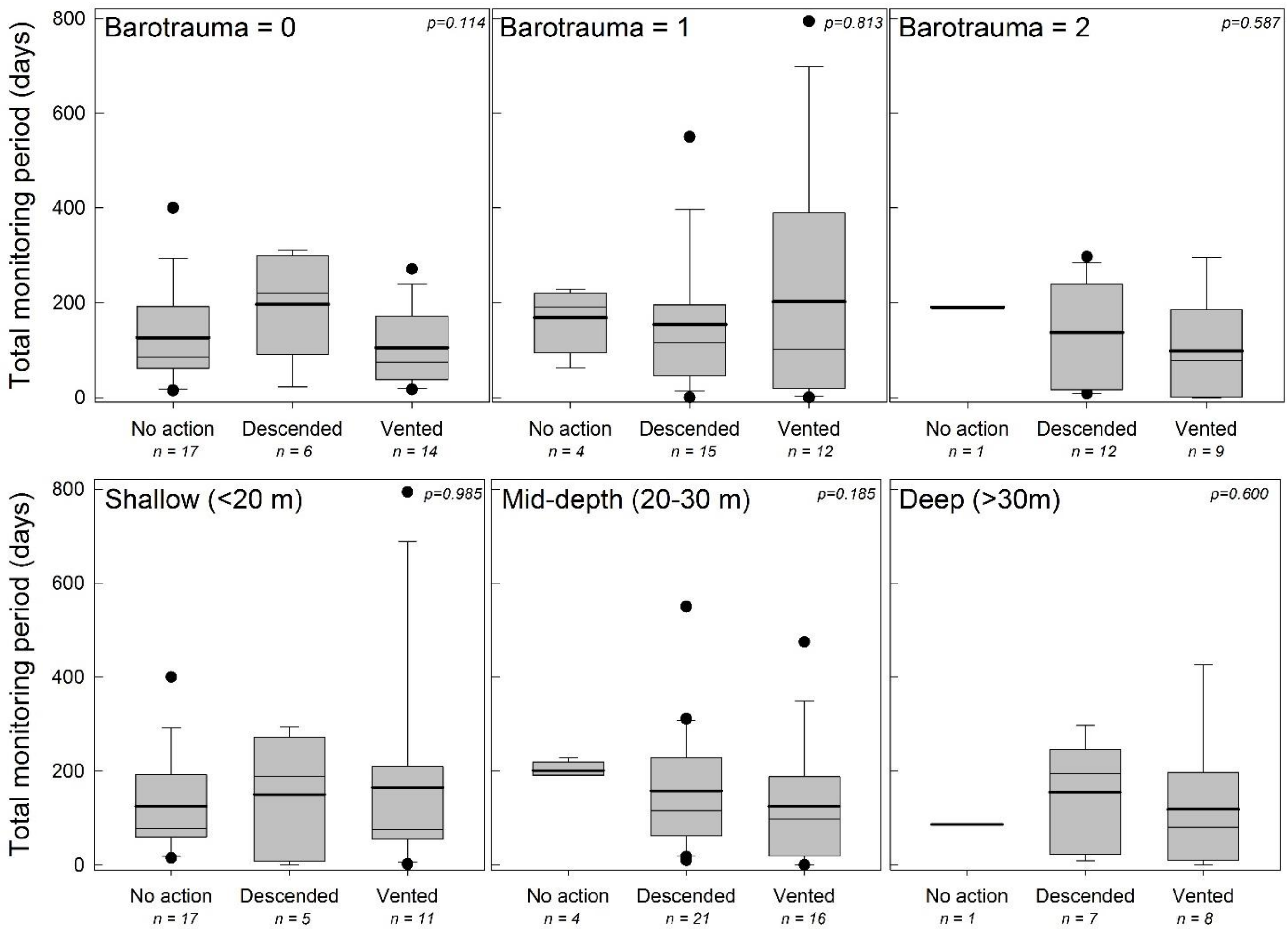


Fig. 14. Total monitoring periods of Gag grouper for each barotrauma group (top panel) and for each depth range fished (bottom panel), separated by barotrauma mitigation treatments. The number of Gag included within each treatment group is indicated in italics along the x-axis. There were no significant differences in monitoring periods between treatment groups (Kruskal-Wallis one way ANOVA, p-values are displayed in top right corner of each graph). Box plots indicate the 25 – 75 quartiles, whiskers indicate 95% confidence intervals, and observations falling outside of the 95% confidence intervals are indicated by (●). The mean and median are indicated by the bold and thin horizontal lines, respectively.

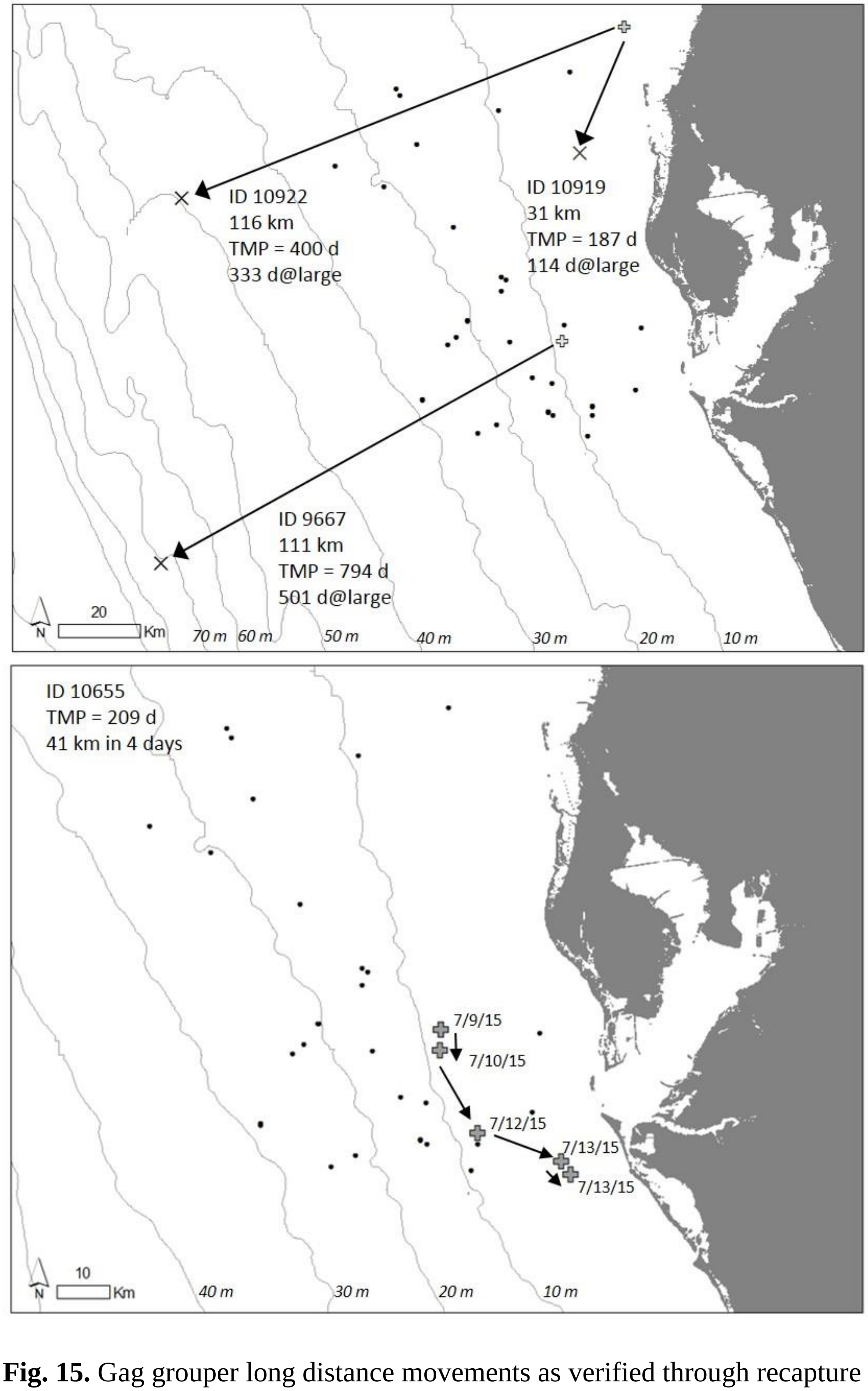
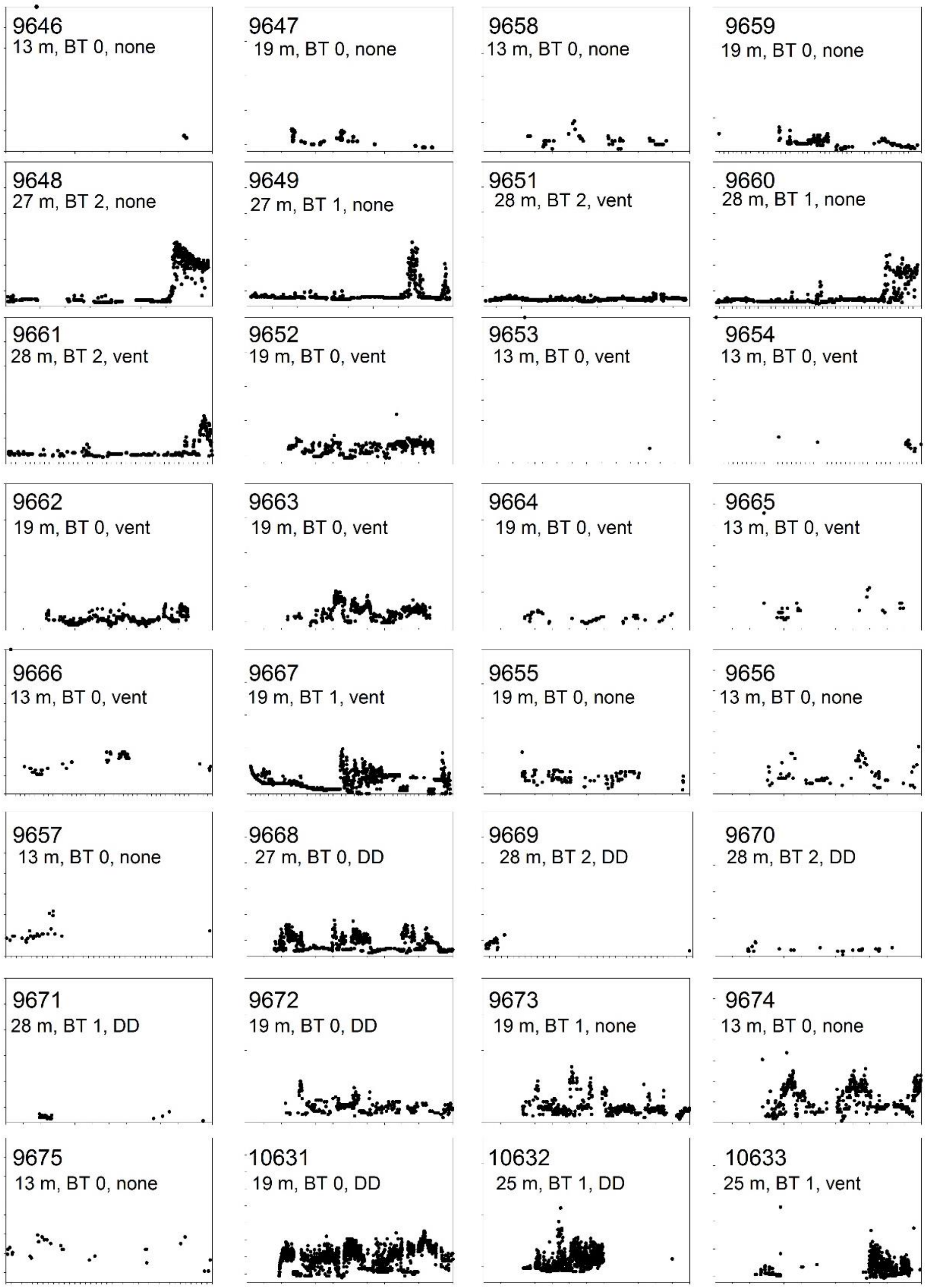
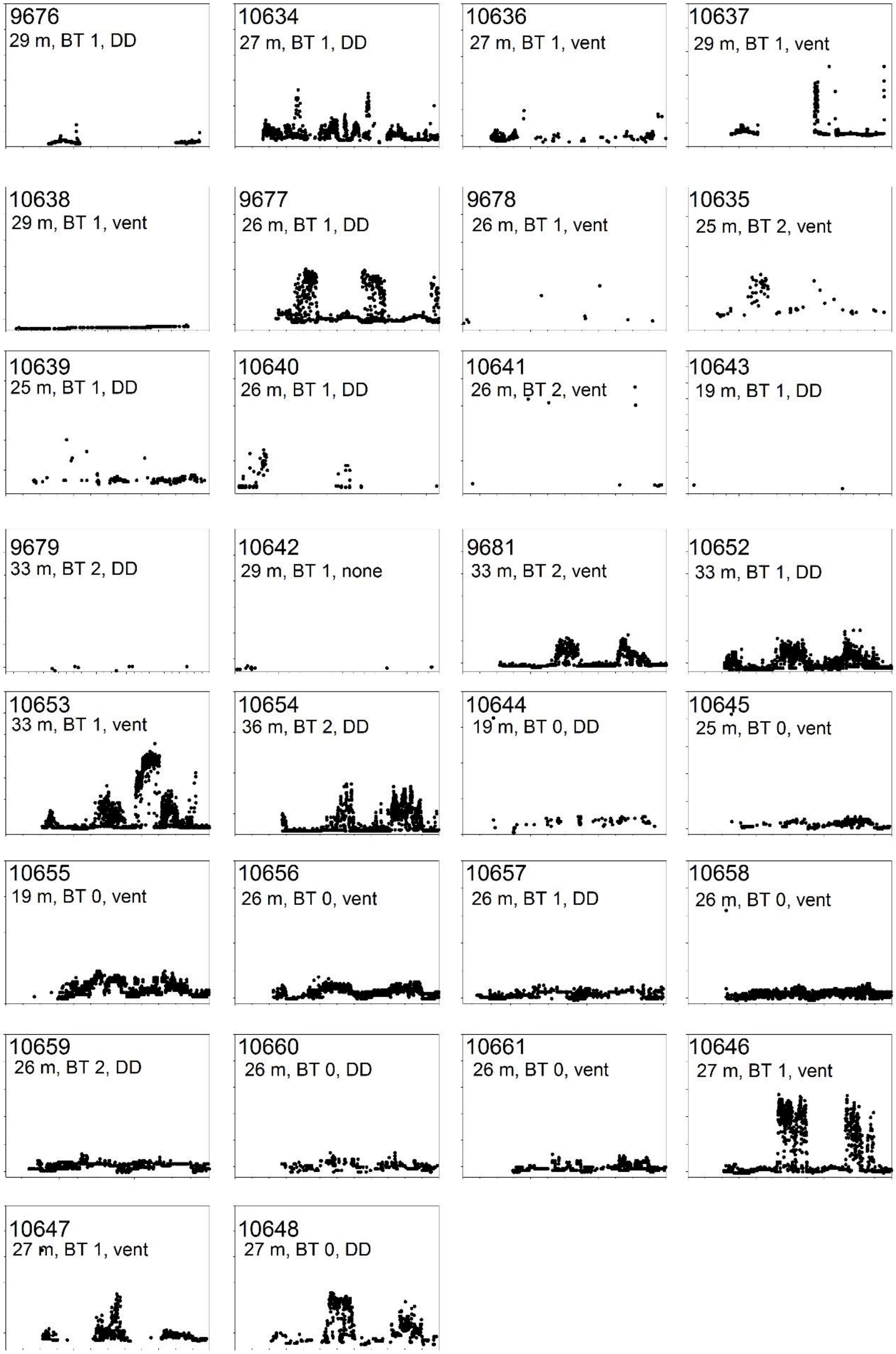
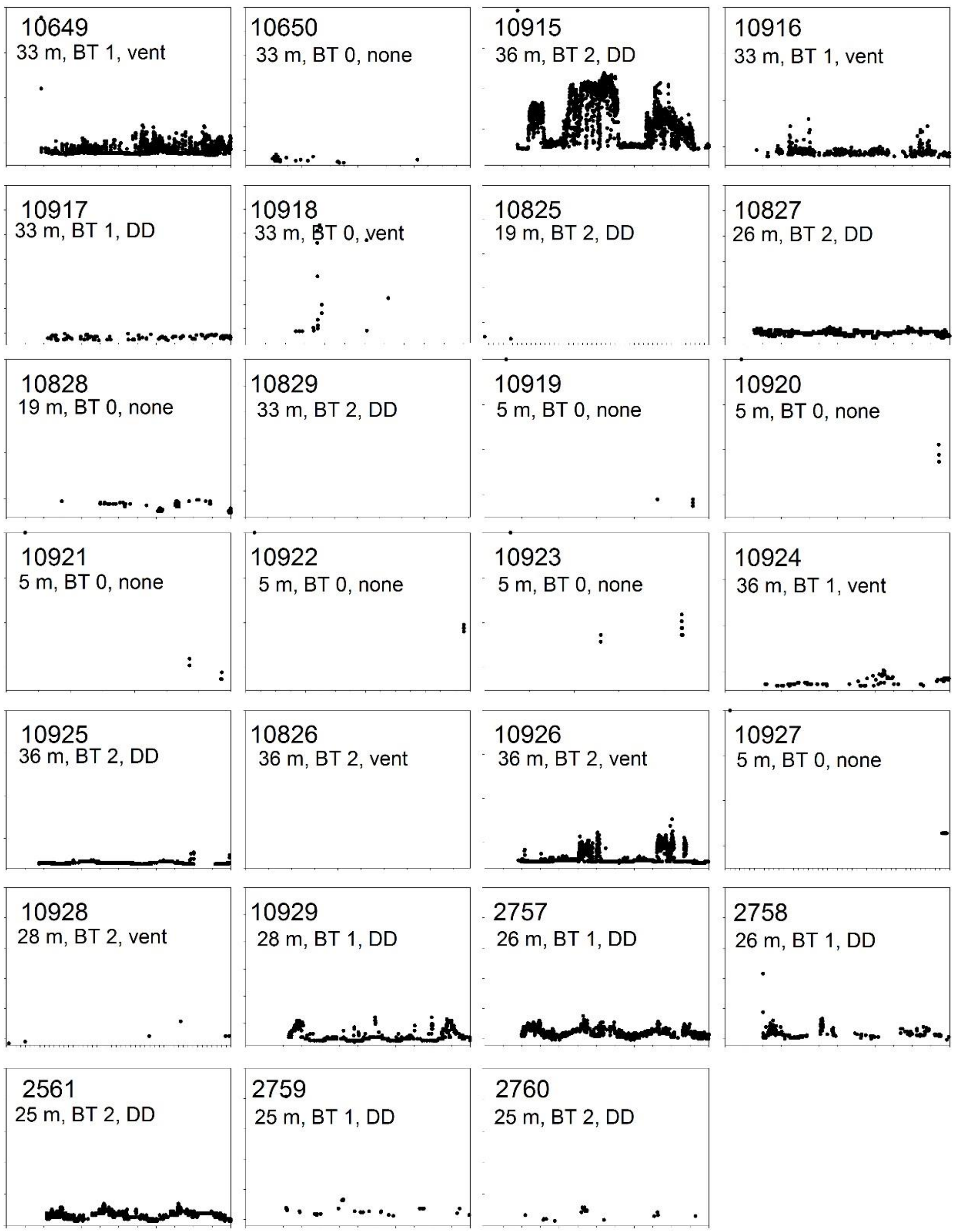


Fig. 15. Gag grouper long distance movements as verified through recapture reports (top) and detection on additional acoustic receivers within the study area (bottom). VR2 locations are indicated by (•). Abbreviations indicate total monitoring period (TMP) and days at large (d@large).

Appendix 1. Raw depth data for the first 48-hours after catch and release. Data are displayed for 90 Gag grouper that were acoustically tagged between December 2013 and December 2016. Each graph is scaled for the site's maximum depth (x-y intercept) to the surface (y-max; depth = 0 m). Site depth, barotrauma severity (BT) and mitigation technique [none, vent, or weighted descent (DD)] are displayed below each pinger ID number.




9676
29 m, BT 1, DD
10634
27 m, BT 1, DD
10636
27 m, BT 1, vent
10637
29 m, BT 1, vent
10638
29 m, BT 1, vent
9677
26 m, BT 1, DD
9678
26 m, BT 1, vent
10635
25 m, BT 2, vent
10639
25 m, BT 1, DD
10640
26 m, BT 1, DD
10641
26 m, BT 2, vent
10643
19 m, BT 1, DD
9679
33 m, BT 2, DD
10642
29 m, BT 1, none
9681
33 m, BT 2, vent
10652
33 m, BT 1, DD
10653
33 m, BT 1, vent
10654
36 m, BT 2, DD
10644
19 m, BT 0, DD
10645
25 m, BT 0, vent
10655
19 m, BT 0, vent
10656
26 m, BT 0, vent
10657
26 m, BT 1, DD
10658
26 m, BT 0, vent
10659
26 m, BT 2, DD
10660
26 m, BT 0, DD
10661
26 m, BT 0, vent
10646
27 m, BT 1, vent
10647
27 m, BT 1, vent
10648
27 m, BT 0, DD


10649
33 m, BT 1, vent
10650
33 m, BT 0, none
10915
36 m, BT 2, DD
10916
33 m, BT 1, vent
10917
33 m, BT 1, DD
10918
33 m, BT 0, vent
10825
19 m, BT 2, DD
10827
26 m, BT 2, DD
10828
19 m, BT 0, none
10829
33 m, BT 2, DD
10919
5 m, BT 0, none
10920
5 m, BT 0, none
10921
5 m, BT 0, none
10922
5 m, BT 0, none
10923
5 m, BT 0, none
10924
36 m, BT 1, vent
10925
36 m, BT 2, DD
10826
36 m, BT 2, vent
10926
36 m, BT 2, vent
10927
5 m, BT 0, none
10928
28 m, BT 2, vent
10929
28 m, BT 1, DD
2757
26 m, BT 1, DD
2758
26 m, BT 1, DD
2561
25 m, BT 2, DD
2759
25 m, BT 1, DD
2760
25 m, BT 2, DD