Characterization of the southeastern US black sea bass (*Centropristis striata*) pot commercial fishery and implications for western North Atlantic right whale (*Eubalaena glacialis*) management and policy

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**ABSTRACT**

A vital component of marine policy is the conservation and management of diverse marine resources. In the southeastern US, commercial fishermen target black sea bass (*Centropristis striata*) with pots from North Carolina to Cape Canaveral, Florida. During the fall through spring fishing season, western North Atlantic right whale (*Eubalaena glacialis*) distribution overlaps the black sea bass commercial pot fishery. Fishermen interviews revealed that the number of pots set ranged from 3 to 240 and the number of pots set per trawl ranged from 1 to 18. Generally, the amount of gear increased from south to north.

1. Introduction

The implementation of marine policy in the coastal environment is increasingly multifaceted and challenging. Among many issues, marine policy managers are challenged with managing different aspects of marine resources, species, essential habitats, fishing effort, destructive gear, bycatch, and economic markets. One such issue is the relationship between commercial fisheries and marine mammals. Evaluating and describing commercial fishing operations in relation to federally protected marine mammal populations is important for conservation and marine fisheries management [1]. In the United States, western North Atlantic right whales continue to be injured and killed in commercial fisheries [2]. On 10 August 2007, the National Marine Fisheries Service (NMFS) published a Final Environmental Impact Statement (FEIS) that analyzed management alternatives to reduce commercial fishery interactions and Atlantic large whales [3]. Among the fisheries to be regulated under the federal rulemaking process was the black sea bass trap/pot fishery. The NMFS evaluated various management measures and decided that the overall approach to reduce fishery interactions for trap/pot fisheries was to modify vertical lines and reduce the vertical ground line profile.

Trap/pot fisheries operating along the US east coast have been implicated in various marine mammal injuries and mortalities [4,5]. Although the southeastern US black sea bass fishery has never been implicated in any whale entanglement; vertical and floating ground lines used in the northeastern US lobster fishery have been involved in various whale entanglements [6,7]. Unlike the southeastern US black sea bass pot fishery, the amount of gear, soak time, and overall fishing effort in the northeastern lobster trap/pot fishery is considerably greater [3]. Nonetheless, it is impossible to estimate the risk associated to the western North Atlantic right whale by black sea bass pot gear.

Section 118 of the Marine Mammal Protection Act (MMPA) mandates that the NMFS publish an annual List of Fisheries (LOF) that classifies each US commercial fishery into one of three categories based on the level of serious injury and mortality of marine mammals that occurs incidental to that fishery—frequent (Category I), occasional (Category II), or a remote (III) likelihood of or no known incidental mortality or serious injury of marine mammals. The black sea bass pot fishery is classified as a Category...
II fishery [3] as part of “Atlantic mixed species trap/pot fisheries.” Section 118 of the MMPA defines a Category II fishery as a fishery in which the annual mortality and serious injury of a marine mammal stock in a given fishery is greater than 1% and less than 50% of the potential biological removal (PBR) level. To reduce marine-mammal injury or mortality from commercial fisheries, the MMPA specifies that NMFS develop and implement take reduction plans, and fishermen participating in a Category I or II fishery are required to comply. The black sea bass pot fishery is therefore subject to the requirements of the Atlantic Large Whale Take Reduction Plan (ALWTRP) [8].

In the United States, black sea bass (Centropristis striata) are an economically important recreational and commercial serranid ranging from New England to Florida [9]. Although black sea bass are typically caught incidentally in otter trawl gear [10], commercial fishermen primarily target black sea bass with fish traps or pots from Massachusetts to Florida. Two stocks of black sea bass have been recognized north and south of Cape Hatteras, North Carolina, USA [11]. However, current genetic research indicates that there is stock mixing; thus, it is unknown whether there is one or more black sea bass stocks [12]. The northern black sea bass stock migrates seasonally as water temperatures vary. In the winter, most fish are found along the continental shelf edge in the southern part of the Mid-Atlantic Bight. In the spring, fish movement is inshore and northward, where spawning occurs in June through October [13–15]. In contrast, the southern black sea bass stock does not appear to seasonally migrate. In the southeastern US, black sea bass are found near live-bottom areas between Cape Hatteras, North Carolina [15], and Key West, Florida [16]. The southern black sea bass stock begins spawning in February and peak spawning occurs in April or May [14].

Western North Atlantic right whales (Eubalaena glacialis) are an endangered species [17] that range from Canada to Florida [18,19]. Calving occurs during the winter in coastal waters off Georgia and northeastern Florida. Migrating and wintering right whales are found in the coastal waters from North Carolina to Florida from November to April with primary areas located off northeastern Florida (Fig. 1) [18–23]. During those months, right whale distribution overlaps that of the commercial black sea bass pot fishery.

At one time, North Atlantic right whales were abundant in both the eastern and western regions of the North Atlantic Ocean [24]. Today, North Atlantic right whales are one of the world’s most endangered mammals, at risk of extinction in the foreseeable future [25–28]. Kraus et al. [29] estimated the population at 291 individuals and Knowlton et al. [30] estimated the population at 295 individuals. In the United States, right whale management is primarily based on the annual NMFS marine mammal Stock Assessment Report (SAR). The 2006 SAR reported that the estimated minimum right whale population was 306 individuals in 2001; however, the population estimate did not incorporate recent birth rates [2]. Today, although the right whale population is likely slightly higher, incorporating recent birth rates, serious threats continue to threaten the population.

Collisions with ships and entanglement in commercial fishing gear are the two greatest threats [2,31]. It has been estimated that at least a third of right whale mortalities each year are a direct result of human activities [32], and several researchers have stated that more than half of the remaining right whales in the western North Atlantic Ocean have experienced at least one ship strike or net entanglement [32]. Other large whale species are also subject to mortality and serious injury from gear entanglement, with a total of 42 in the western North Atlantic Ocean during 1999 through 2003 [33]. Overall, right whales had the highest proportion of entanglements and ship strikes of any species. Of the 50 reports involving right whales, 31 were confirmed entanglements, 5 resulting in serious injury and 3 resulting in mortalities.

Given the mounting concern about the status of the right whale population in the western North Atlantic and the continued threat by commercial fishing operations, the purpose of this investigation is to describe the black sea bass pot fishery in southeastern US waters. The goals are to characterize the southeastern US black sea bass pot fishery in terms of gear, methods, and effort in order to assist fishery policy managers with developing appropriate conservation and protective management measures for the recovery of the western North Atlantic right whale.

2. Material and methods

Between January and May 2004, interviews were conducted with fishermen and fish dealers from major fishing ports in North Carolina, South Carolina, and Georgia. On numerous occasions throughout the study period, commercial fishermen were interviewed and gear was evaluated by NMFS commercial fishery liaison personnel. In addition, fishermen phone interviews were conducted by NMFS fishery biologists.

Based on NMFS Southeast Regional Office management jurisdiction (southeastern waters: North Carolina to Florida), four areas were defined for comparison: northern North Carolina, southern North Carolina (with the separation at Cape Look, North Carolina), South Carolina, and Georgia. In each area of the four areas, the amount of pot gear and methods were graphed, evaluated, compared, and summarized. The calculated mean number of pots and trawls were normally rounded (round up or down to the next whole number). A non-parametric Kruskal–Wallis one-way analysis of variance on ranks was used to test for differences among areas in the total number of pots fished, pots per trawl, and ground line diameter. Mann–Whitney post hoc comparison tests and the evaluation of Box and Whisker plots were used to determine specific significant differences among mediums. All statistical analyses were conducted using Microsoft Excel and results were considered significant at the P<0.05 level.

3. Results

Between January and May 2004, 42 fishermen were interviewed from 14 different southeastern US fishing ports across three US states. Overall, cooperation of fishermen with NMFS representatives was excellent throughout the investigation. Southeastern US fishing ports were categorized under four specific geographical areas (Fig. 2): (1) northern North Carolina (Wanchese, Cape Hatteras, Beaufort, and Cape Carteret); (2) southern North Carolina (Sneads Ferry, Topsail Sound, Topsail Beach, Wrightsville Beach, and Carolina Beach); (3) South Carolina (Little River, Murrells Inlet, Georgetown, and Cape Romain Harbor); and (4) Georgia (Sapelo). Seven fishermen (17%) interviewed were from northern North Carolina ports, 17 (40%) fishermen were from southern North Carolina, 16 (38%) were from South Carolina, and two (5%) fishermen were from Georgia.

3.1. Fishing gear

The words “pot” and “trap” are used interchangeably to mean baited boxes set on the ocean floor to catch various fish and shellfish. The gear can be circular, rectangular, or conical in shape. In the southeastern US, commercial fishermen use fish traps
(pots) to capture black sea bass. Black sea bass pots are similar to lobster traps in shape (usually rectangular or cylindrical), construction, and size. Generally, black sea bass pots are set in trawls attached to a ground line along the ocean bottom, which is sometimes called a string. Strings are anchored on each end and a vertical line is attached to a buoy, buoy/flag combination, or highflyer. Based on interviews, fishermen reported that black sea bass pots were generally constructed using three different mesh sizes depending on fishermen preference: (1) $3.8 \times 3.8$ cm ($1.5 \times 1.5$ in.) square mesh, (2) $3.8$ cm ($1.5$ in.) hexagonal mesh (PVC-coated or chicken wire), or (3) $5 \times 5$ cm ($2 \times 2$ in.) mesh. Because of durability in the marine environment, coated nylon, cotton, or hemp was more common, while coated chicken wire was the least common material used for mesh construction. Some fishermen also reported using even a smaller mesh sizes in belief that it created a dark "cave-like" effect which would be more
tempting for fish to enter, until small mesh sizes were prohibited beginning 21 September 2006. To minimize the impacts of lost gear “ghost gear”, federal regulations require all pot hinges and fasteners to be constructed with degradable material; each pot requires two escape vents, and each pot requires an identification tag attached.

Fishing practices varied among fishermen and geographical area. Overall, the number of pots set ranged from 3 to 240 (Fig. 3) and the number of pots set per trawl ranged from 1 to 18 (Fig. 4). Generally, the number of pots set and the number pots set per trawl increased from southern to northern geographical areas. Southern and northern North Carolina fishermen significantly set

Fig. 2. Major southeastern US commercial black sea bass pot fishing ports and grounds [18–23].
more pots than fishermen in Georgia or South Carolina (Kruskal–Wallis test, \(P<0.001\)). However, no significant differences were found between the number of pots set in Georgia or South Carolina. In southern North Carolina, fishermen set fewer pots than in northern North Carolina (Kruskal–Wallis test, \(P<0.001\)). Also, the number of pots per trawl in northern North Carolina was significantly greater than for any other area (Kruskal–Wallis test, \(P<0.001\)); however, no significant differences were detected in the number of pots per trawl among the other geographical areas (southern North Carolina, South Carolina, Georgia).

Overall, slightly more fishermen (57%) reported using a buoy/flag combination for marking gear than buoys alone. Buoy line diameter was \(\frac{1}{4}\) in. (6.4 mm), \(\frac{5}{16}\) in. (7.9 mm), or \(\frac{3}{8}\) in. (9.5 mm). After data transformation, an ANOVA test showed that there were significant differences in mean line diameter among areas (\(P<0.005\)). Buoy line diameter used in North Carolina was significantly greater in size than what was used in South Carolina or Georgia. Most fishermen (60%) reported using line constructed of polypropylene with the remainder indicating that a combination of polypropylene or Dacron was used.

In northern North Carolina, the number of pots per trawl ranged from 1 to 10 and the mean number of pots per trawl was five (Fig. 5). The relationship between the mean number of pots per trawl set from northern North Carolina to Georgia was described by the following linear regression: \(y = -1.4x + 6\) (\(r^2 = 0.89\)). The total number of pots fished ranged from 20 to 50 and the mean number of pots was 41 (Fig. 6). The relationship between the mean number of pots set from northern North Carolina to Georgia was described by the following linear regression equation, but was not significant: \(y = -13.7x + 74.5\) (\(r^2 = 0.31\)). Every fishermen interviewed indicated that a buoy and flag combination system was used for marking gear on each end. The average fishing depth ranged from 8 to 125 m (25–400 ft), with most fishermen (57%) setting gear in 6–22 m (20–70 ft). The buoy line length ranged from 47 to 188 m (150–600 ft), with most fishermen using buoy line lengths between 47 and 94 m (150–300 ft). For fishermen using more than one pot per trawl, the ground line length between each pot ranged from 3.1 to 6.3 m (10–20 ft). Most fishermen used ground line lengths between 3.1 and 4.7 m (10–15 ft), and the majority of buoy line (57%) was either \(\frac{3}{8}\) in. (9.5 mm) or \(\frac{5}{16}\) in. (7.9 mm) diameter polypropylene line. Interviews indicated that the average distance from shore to the fishing grounds ranged from 16 to 64 km (10 and 40 miles).

Fishermen from southern North Carolina indicated that the number of pots per trawl ranged from 1 to 18 and the mean number of pots per trawl was 3, with most fishermen using either 1 or 2 pots per trawl (Fig. 5). The total number of pots fished ranged from 20 to 240 and the mean number of pots was 81 (Fig. 6). Every fisherman interviewed indicated using a buoy and flag combination system for marking gear. Fishermen indicated that fishing depth ranged from 9 to 38 m (30–120 ft), with most fishermen setting gear in 13–31 m (40–100 ft). Buoy line length ranged from 16 to 56 m (50–180 ft), and most fishermen used buoy line lengths between 19 and 38 m (60–120 ft). For fishermen setting more than one pot per trawl, the ground line length between each pot ranged from 6 to 19 m (20–60 ft), with most
fishermen using ground line lengths between 8 and 13 m (25–40 ft). Regardless of the number of pots per trawl set, all buoy lines were constructed of 3/8 in. (9.5 mm), 5/16 in. (7.9 mm), or 1/4 in. (6.4 mm) polypropylene or Dacron. Interviews indicated that the average distance from shore to fishing grounds ranged from 16 to 64 km (1 and 40 miles).

In South Carolina, every fishermen interviewed indicated using only one pot per trawl (Fig. 5). The total number of pots fished ranged from 3 to 30 and the mean number of pots was 21 (Fig. 6). Six fishermen indicated using a buoy and flag combination system, and eight fishermen indicated using only buoys for marking gear on each end. The average fishing depth ranged from 14 to 38 m (45–120 ft), with most fishermen setting gear in 16–34 m (50–110 ft). The buoy line length ranged from 23 to 50 m (75–160 ft), but most fishermen (50%) used buoy line lengths between 23 and 47 m (75–150 ft). Since all the fishermen used single traps, no ground lines were used. All buoy line used was constructed of 5/16 in. (7.9 mm) polypropylene or 1/4 in. (6.4 mm) Dacron. Interviews indicated that the average distance from shore to the fishing grounds ranged from 19 to 72 km (12 and 45 miles).

Similar to South Carolina fishermen, the two fishermen interviewed from Georgia indicated using only one pot per trawl (Fig. 5). The total number of pots fished ranged from 6 to 30 and the mean number of pots was 18 (Fig. 6). Both fishermen indicated using a buoy and flag combination system for marking gear on each end. The average fishing depth ranged from 18 to 48 m (70–150 ft). The buoy line length ranged from 38 to 63 m (120–200 ft). Both fishermen did not use any ground lines and indicated using buoy line constructed of 5/16 in. (7.9 mm) polypropylene. The average distance from shore to the fishing grounds was between 32 and 65 km (20 and 40 miles).

3.2. Fishing methods

Fishermen used two different methods for targeting black sea bass in southeastern US waters. The primary technique was “target setting” and the second technique was “scattered setting.” Fishermen reported using the “target setting” technique to catch winter sessile black sea bass aggregations located on hard-bottom habitats. To locate hard-bottom areas, fishermen either used onboard electronics or set numerous pots in clusters over extended areas. Gear was typically set any where from 3 to 5 m (10–15 ft) to 5 to 8 km (3–5 miles) apart. With this technique, pots were set and retrieved frequently, depending on fishing success.

In contrast, fishermen that used the “scatter setting” targetted winter migratory black sea bass instead of sessile aggregations. With this technique, fishermen set many pots over a wide area and gear was set in rows or scattered. With this technique, pots were set for extended periods with the intention of attracting fish to the pot. Unlike target setting, scattered setting was not dependent upon bottom habitat type.

Regardless of the deployment method, fishermen either set and retrieved gear exclusively during the day or allowed gear to soak. In northern North Carolina, four (50%) of the fishermen interviewed indicated that gear was set and retrieved only during the day and no gear was set overnight. However, in southern North Carolina, 10 (59%) fishermen interviewed indicated that gear was set overnight and retrieved during the day. In South Carolina, fishermen indicated that no pots were set overnight; however, in Georgia, both fishermen interviewed indicated that pots were set overnight and gear was retrieved during the day. Interviews also revealed that if fishermen set gear during the day, then all pots were tended, but if gear was set overnight, then gear was unattended. On average, fishermen from all regions indicated that fewer pots were set during the winter than during the summer periods. During the summer, when fish were more scattered, fishermen were inclined to set more gear and increase soak times. However, during the winter, less gear was set and soak times were shorter, with pots hauled two to three times a day. Overall, soak time were dependent on gear amount and weather conditions. If fishermen set single pots, then soak times were short; however, if gear was set in trawls, then soak times were longer.

3.3. Fishing season

Overall, the southeastern US black sea bass fishery was regularly prosecuted during winter through spring, and at various locations, fishermen reported seeing whales on occasion in the vicinity of gear during this period. In northern North Carolina, five (57%) fishermen set gear from January through April, while the other two fishermen interviewed indicated setting gear throughout the year. In southern North Carolina, 14 (82%) fishermen set gear either in the fall, winter, both seasons or throughout the year. In South Carolina and Georgia, every fisherman interviewed indicated setting gear only during the fall through winter seasons.

3.4. Fishing effort

Fishing effort was unable to be quantified or estimated through fishermen interviews. The majority of fishermen indicated participating in various fisheries and overall effort was dependent...
on fishing success, economic markets, or weather conditions, so the number of days fished per year varied. Although, fishermen are federally required to register the number of black sea bass pots, estimating effort was difficult because many snapper-grouper permit holders maintained black sea bass endorsements, though they are not actively involved in the pot fishery. As a result, the number of fishermen permitted to fish with pots is much higher than the actual number that are fishing. Moreover, fishermen tend to set only a portion of their pots while storing the remaining pots to replace any losses during the season [12]. In 2003, the total number of black sea bass pot tags was 3720 [2]. There were 130 pot tags issued in Florida (includes both east and west coast), 45 tags issued for Georgia, 920 tags issued for South Carolina, and 2625 tags issued for North Carolina. Landing information indicated that 66.8% or 159,939 kg (351,864 lb) were landed in North Carolina; the remainder was landed in South Carolina (7.6%) and other areas (4.8%).

Today, there are no black sea bass fishery observer program requirements to facilitate gathering fishery data and the black sea bass pot fishery is not “limited access” either; however, the South Atlantic Fishery Management Council (SAFMC) did set a control back-date of 23 April 1997. By setting a control date, the SAFMC could decide to implement a limited access program at a later time. If so, fishermen entering the fishery after the control date would no longer be authorized. Based on the final rule implementing various new regulations for several species, including black sea bass [34], the SAFMC considered, decided not to restrict the number of sea bass pots fishermen could deploy. Moreover, the SAFMC considered, but also decided not to require fishermen to return to the dock with all pots after each trip. Instead, the SAFMC decided to implement a black sea bass quota of 216,364 kg (477,000 lb) which was expected to restrict the number of pots set per year once the quota was met.

4. Discussion

This study did not interview every black sea bass pot fisherman from every southeast geographical area or fishing port; however, according to local seafood dealers and commercial fishing supply companies, interviews were conducted with commercial fishing industry leaders from most of the major southeastern US fishing ports. Thus, these results should be representative of the overall black sea pot fishery in terms of gear characteristics, fishing method, and fishing season. This investigation revealed that the black sea bass pot fishery in southeastern US waters was primarily prosecuted during the fall and winter months and the geographical areas (nearshear waters) when western North Atlantic right whales are migrating from the north to south. Although whale sighting information could not be quantified, some fishermen reported observing whales in the vicinity of gear during the fall and winter months. From this investigation, it was difficult to differentiate which geographical area had the most fishing effort; however, based on interviews, it appeared most fishermen set more gear off North Carolina waters than off South Carolina or Georgia waters, where more western North Atlantic right whales reside during the winter through spring months. However, more fishermen were interviewed in northern areas than in southern areas, possibly biasing the results; nonetheless, interviews indicated that the distribution of fishermen interviewed correctly reflected that of the fishery in terms of effort. Overall, findings appear beneficial for seasonal right whale movements; however, limited information is available regarding right whale migration patterns within North Carolina waters during the fall and winter periods. In general, the amount of gear increased from southern fishing areas to northern fishing areas. More importantly, fisherman revealed that soak times and the distance between pots in the winter months were less than in the summer months, which actually could increase the threat to right whales. However, no information is available to determine whether more traps in a smaller area reduces or increases the risk to right whales, so it is difficult to speculate either way. Lastly, the study found that most fishermen used “floating” polypropylene line and almost every fisherman used a buoy/flag configuration to mark the ends of the gear. Without any verification studies available, but based on amendments to the ALWTRP, it is a standard management belief that polypropylene line is a greater threat to whales than sinking line. In the southeast, interviews discovered that most fishermen use polypropylene line because it is less probable to become entangled with hard-bottom habitats.

As previously stated, it is difficult to ascertain the threat of black sea bass pot fishery gear to right whales in US southeastern waters. Thus, fishery managers held public meetings, reviewed public comments, and evaluated various alternatives for reducing threats to large whales [35]. Based on these outcomes, the NMFS decided, among other things, to implement Seasonal Area Management (SAM) regulations for the southeastern US black sea bass pot fishery [2]. In the near future, conservation management measures will consist of the requirement to use sinking and/or neutrally buoyant ground line, extending the universal buoy line requirements (which prohibit any portion of the buoy line floating at the surface), and requiring that pot gear employ weak links on all floatation and/or weighted devices attached to the buoy line.

Incorporating weak links into buoy lines has been a long-standing accepted theory by NMFS and others as a method for reducing entanglements and serious injury to large whales [2]. The operational theory is based on the idea that the whale’s forward motion will pull the buoy line through the whale’s mouth until the buoy and weak link catch beside the baleen, then the combination of the whale’s momentum and the weight of the gear on the lower end of the buoy line will cause the weak link to break [35]. While this theory has never been tested due to the difficulty of experimenting on large whales; nonetheless, the NMFS considers adding a weak link on all devices attached to the buoy line will increase the likelihood that a line sliding through a whale’s mouth will break away quickly at the buoy before the whale begins to thrash and become more entangled. To better understand fishery interactions, the NMFS has convened various entanglement workshops and evaluated various fisheries; however, at this time, NMFS believes that the gear requirements stated above are the only alternative measures available to reduce large whale entanglements.

In addition to the conservation and protected measures implemented under the ALWTRP, recent regulations for the black sea bass fishery [34] should have secondary conservation benefits for right whales, since it is probable that the black sea bass quota would be met early in the year thereby prohibiting gear and fishing effort during the period when western North Atlantic right whales are regularly migrating to southern waters. In this circumstance, both of these regulations will likely assist with the conservation and management of several marine resources; however, this is unusual for the fishery management process. Typically, conservation management measures for one species may actually unintentionally negatively affect another species, especially marine mammals (e.g. sea lions and salmon). Historically, as fisheries and technologies were established, fishery interactions with marine mammals have increased. Today, many marine mammal populations have been negatively impacted by commercial fisheries, since many marine mammal diets consist of the same fisheries targeted by fishermen [36].

Although, federal fishery managers have excellent marine resource management intentions, regulatory processes often do
not allow for effective fast decision making, which can sometimes take many years (J. Levesque, pers. obs.). For long-lived species (e.g. marine mammal, sea turtles, sharks, and abalone), usually management measures are implemented after a species has already severely declined and probably will never recover because of either life history traits or competing fishery management priorities [37]. As with the western North Atlantic right whale, many marine mammal populations continue to decline due to continuing commercial fishery interactions [7], even though large whale management measures for commercial fisheries have been in place for many years [8]. As previously stated, ship strikes are the leading cause of death to right whales [24,38]; however, more stringent management measures under the NMFS Ship Strike Reduction Strategy were not proposed until recently [39]. With less than 400 right whales remaining, it is obvious that current management approaches to reducing threats to right whales are failing.

5. Conclusions

Western North Atlantic right whale management has been extremely challenging. The NMFS must balance the requirements of the MMPA, the ESA, and the Magnuson-Stevens Conservation Act while promoting the growth of fisheries and managing bycatch. With the difficulty of conducting open-ocean experiments on large animals, researchers are often restricted in their abilities to test new technologies. Thus, in the absence of reducing fishing effort and closing fisheries, the NMFS is attempting to reduce whale–fishery interactions by implementing the “best available” information. Nonetheless, the new NMFS management measures imposed on the southeastern US black sea bass pot fishery may actually negatively affect right whales by creating additional vertical lines in the water column by fishermen switching from multiple pots to single pots in northern North Carolina waters. It is probable that some fishermen will fear setting pot gear on or adjacent to hard bottom areas with the new sink ground line requirement in belief they will lose gear. However, since the majority of the fishery already deploys single pots, as pointed out by this study, it is anticipated that the NMFS measures should not significantly influence effort, fishing seasons, or techniques. Further, it is anticipated that the recent black sea bass fishery quota should benefit right whale conservation. Therefore, any potential negative effects imposed by the new sink line requirement for ground lines from fishermen setting single pots instead of multiple pots may not arise, since the black sea bass quota is expected to be met early in the year, thereby closing the fishery before right whales migrate through the area.

The success of implementing right whale conservation measures will be difficult to assess considering fishery interaction determinations of large whales with commercial fishing gear are often vague or best judgment speculation. Currently, there is no criteria developed for measuring marine mammal management success; thus, all injuries and mortalities are often pooled and evaluated against the MMPA’s PBR level definition or in the case of threatened or endangered species the ESA’s jeopardy definition. Many management decisions are often subjective and based upon a policy maker’s ability to interpret what level of decline warrants action, since risk analysis and probability modeling are mostly lacking. This approach to assessing population declines has recently been evaluated by Taylor et al. [40]. In this study, the researchers evaluated the current approaches used to detect declining trends in marine mammal populations and conclusively determined that it was apparent that the current system was not appropriate for detecting precipitous marine mammal abundance declines. Thus, changes in the current system should be considered.

In order for fishery policy managers to make suitable conservation and protective management decisions, cooperative support from the commercial fishing industry, increased monitoring effort for marine mammals, and new analytical methods for detecting marine mammal population declines are crucially needed. It is important for whale biologists and industry fishing representatives to have the ability to test new theories and technologies without extended regulatory delays imposed by the requirements of the MMPA, the ESA, the National Environmental Policy Act, and the Data Quality Act. Although, the NMFS does convene workshops to gather information, often scientific information is nonetheless lacking; thus, to facilitate the implementation of fitting whale management actions and in a timely fashion, the current system needs to be streamlined and faster, so that fishery policy makers can adequately evaluate quality, appropriate, and relevant information.

Results from a recent review of marine governance by Hilborn et al. [41] found that the current fishery management approaches and systems repeatedly create many of the problems (discards, marine mammal fishery interactions, bycatch) associated with proposed fishery solutions (regulations). The review revealed that marine resources benefited from incentives to individuals, which ultimately led to conservation consistent behavior [41]. In the USA, currently there are no incentives for fishermen to develop and test gear for reducing marine mammal fishery interactions besides the threats of fishery closures. As highlighted by this study, although black sea bass pot fishermen were extremely cooperative with fishery managers throughout this study, no incentives were available. In fact, additional regulations were imposed on the fishery. Generally, fishery closures often occur when fishery populations have already collapsed or when marine mammal interactions increase to levels above PBR, so the only incentive for fishermen is to “race-to-fish” or to “catch all you can” before fisheries close or new regulations are imposed. As competition increases for limited resources among competing fisheries and marine mammals for prey [1], it is imperative that effective ecosystem management approaches be developed as soon as possible. Nonetheless, some researchers cautioned against moving forward with the ecosystem management approach, since there are already many uncertainties with using the current single species management approach [40]. In summary, the precautionary principle [42,43] to promoting or closing new fisheries must be continued to be used and more importantly although the NEPA public process is important, the system needs to be more streamlined, so that marine resources (e.g. fishery stocks, marine mammals) receive the proper protection before it is to late.

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References