The full report will be posted to the Council website (www.mafmc.org) upon completion of the reviews.

1. Title Page

Project Title: Estimating and mitigating the discard mortality rate of black sea bass in offshore recreational rod-and-reel fisheries

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2. Executive Summary

In late fall and winter, black sea bass migrate offshore towards the edge of the continental shelf and overwinter at deep shipwrecks and reefs (45-80+ m). The recreational fishery catches black sea bass offshore during the winter both as the target species and as bycatch while targeting other species (e.g., scup, pollock, hakes, cod, tilefish). Black sea bass are often discarded by recreational anglers during these offshore winter fisheries due to factors such as size restrictions, daily possession limits, “high-grading”, or closed seasons. The discard mortality rate of black sea bass has been previously investigated for inshore fisheries conducted in relatively shallow water and warmer seasons (i.e., spring through fall), but the discard mortality rate of black sea bass in the winter offshore recreational fishery has not been previously investigated. As a result, this project focused on providing a robust discard mortality rate estimate for the offshore black sea bass recreational fishery in the Mid-Atlantic to inform stock assessments and fishery management, and provide best-practice recommendations for anglers to reduce discard mortality.

We conducted an extensive tagging study involving collaboration among recreational fishing industry stakeholders, volunteer anglers, commercial fishermen, and scientists. Fieldwork was conducted from November 2016 through March 2017, and included eight research tagging charters aboard recreational headboats. Our primary study site was the Ice Cream Cone shipwreck, which is situated in 45 m depth and ~85 km southeast of Sea Isle City, NJ. A total of five research tagging charters were completed to the Ice Cream Cone shipwreck from early December 2016 through early February 2017. Two additional tagging trips were completed to the Baltimore Rocks (67 m depth) in February 2017 and one trip to the Indian Arrow shipwreck (58 m depth) in late March 2017. On all tagging trips, volunteer anglers were provided with standardized terminal tackle rigs, whose configuration was established based on a survey of 282 recreational black sea bass anglers. The use of this standardized terminal tackle ensured that black sea bass were captured under authentic scenarios that are representative of the Mid-Atlantic offshore recreational fishery. For each captured black sea bass, a series of technical (e.g., capture depth, angler experience level, fight time, unhooking time, handling time, hooking location, hook removal method), biological (e.g., total length [TL], release behavior, injury, barotrauma symptoms), and environmental (air temperature, sea surface and bottom water temperature) variables were recorded to investigate which factors significantly influenced discard mortality.

Since black sea bass captured in deep water often experience barotrauma, we also examined the effect of swim bladder venting (when done properly) on fish submergence (i.e., the ability to swim back down to the bottom after release) and discard mortality. To accomplish this, fish were released at the sea surface either with no intervening measures (i.e., unvented) or following swim bladder venting with a hollow needle by a trained scientist. At the Ice Cream Cone shipwreck, we tagged a subsample of fish with pressure sensing Vemco acoustic transmitters and monitored their movements post-release using an array of 30 acoustic receivers maintained in collaboration with commercial fishermen. Almost all other sampled fish were tagged with conventional t-bar anchor tags and released to investigate migration patterns and confirm survival if recaptured.

A total of 1,823 black sea bass (136 - 612 mm TL) were sampled throughout the three study sites. Of all sampled fish, 1,713 were released (i.e., some were retained for ageing), including 957 that were vented and 756 unvented. A total of 1,467 fish were tagged with conventional t-bar anchor tags. At our main study site, the Ice Cream Cone shipwreck, 566 fish were sampled, and a subset of 96 fish (278 - 546 mm TL) tagged with acoustic transmitters, 48 of which were vented (278 - 546 mm TL) and 48 were not vented (279 - 485 mm TL). Fight times for captured fish ranged from 12 - 251 (Mean ± SD: 78 ± 32) seconds for the full sample. Capture of larger fish at deeper depths by low speed reels, or capture as part of a double header increased fight time. The majority of fish were hooked in the mouth. Released black sea bass exhibited four release behaviors including erratic swimming, sinking, floating, and swimming down, with the vast majority exhibiting the latter two behaviors. Results of a logistic regression indicated that fish total length, capture depth, venting, and the presence of exopthalmia influenced release behavior, with larger fish, that were not vented, caught at deeper depths, and experienced exopthalmia had a lower probability of swimming down.

A total of 304 (17%) black sea bass incurred injuries (i.e., wounds > 2 cm), mostly as a result of hooking trauma and/or the hook removal process. Twelve individuals (0.4%) were dead upon landing, with most having been bitten in half by predators or experienced ripped gills from hooking. The majority (82%) of captured individuals exhibited no injury. The vast majority (95%) of captured black sea bass exhibited symptoms of barotrauma. Stomach eversion was the predominant barotrauma symptom, with stomach eversion score 2 (i.e., stomach protruding from the mouth cavity) being present in 68% of all captured fish. Exopthalmia was present in ~10% of all captured fish. Barotrauma symptoms were generally more prevalent at deeper depths, particularly exopthalmia, which was most prevalent at the deepest capture depth of 67 m.

Acoustic detection data were obtained for 94 of the 96 black sea bass tagged with acoustic transmitters. The two undetected fish exhibited floating behavior and both possibly experienced avian predation. Survivorship of individual black sea bass tagged with acoustic transmitters was objectively determined by a multi-step process that compared their vertical and horizontal movements to those of 'known alive' (positive controls, n=7) and 'known dead' (negative controls, n=2) fish. Of the 94 black sea bass that were detected within the receiver array, 61 survived the capture and handling process and were considered to be alive and 33 died after release. Of the 33 mortalities, nine were attributed to predation following re-submergence. All predation events occurred within 1.8 - 18.4 (7.2 ± 4.5) hours of release. All of the remaining 24 mortalities were assumed to have occurred due to the fishing event, and occurred from 5.0 - 128.0 (17.1 ± 26.7) hours post-release. Of these, 19 (79.2%) mortalities occurred within 24 hours of release, four from 24 - 72 hours post-release (16.7%), and one (4.2%) >72 hours post-release (95.8% of mortality occurred within 72 hours).

Final black sea bass survivorship data were analyzed with the non-parametric Kaplan-Meier estimator and the semi-parametric Cox proportional hazards model to evaluate the suitability of capture-related variables (i.e., covariates) for predicting survival and to identify a parsimonious subset of covariates that best predict survival. Once the subset of influential covariates was identified, a parametric survival analysis modeling approach was used to assess potential models that can describe survivorship over time and estimate overall discard mortality. The results of our survival analyses suggested that swim bladder venting was the most significant predictor of mortality in released black sea bass. Based on the model results, the mean total fishing-related (i.e., discard) mortality rate at the Ice Cream Cone shipwreck in 45 m depth was 0.21 (95% CI: 0.12, 0.37) for vented black sea bass and 0.52 (95% CI: 0.38, 0.67) for unvented black sea bass. When looking only at unvented fish, fight time was the most significant predictor of mortality, with increased fight time (>54 seconds) resulting in a markedly higher discard mortality rate. Based on these findings, discard mortality for both vented and unvented fish may have been elevated at the deeper locations due to the higher mean fight times of 80 seconds at the Indian Arrow shipwreck (58 m) and 94 seconds at the Baltimore Rocks (67 m).

Given that swim bladder venting (when done correctly) was the most influential factor on discard mortality and increased submergence success over all depths, we recommend that anglers vent all black sea bass that are captured during the offshore winter fishery before they are released, particularly those that experience barotrauma symptoms. However, full realization of the benefits of venting will require continued education and outreach on proper venting techniques and recommended venting tools. Based on this study, swim bladder venting would be the best practice for reducing discard mortality, but given that longer fight times significantly increased discard mortality of unvented fish, we recommend the following practices as additional options for reducing fight time and therefore also discard mortality: target black sea bass in as shallow of water as possible, reel in fish at a moderate to fast pace, use appropriate strength tackle that can easily land black sea bass in deep water, and consider using single hook rigs given that double header catches had longer fight times. In addition, the impacts of dead discards could be reduced by avoiding the targeting of other species in fishing locations and seasons when black sea bass retention is prohibited, or avoiding locations and seasons when undersized black sea bass that have to be released are the primary catch.

In conclusion, our study estimated mean discard mortality rates of 21% for vented and 52% for unvented black sea bass following capture and release in 45 m depth. Given that venting is not commonly practiced in the fishery, the 52% estimate for unvented fish is most representative of the current discard mortality rate when the fishery operates at (or near) this depth. However, due to increased fight times, the discard mortality rate is expected to be higher at greater depths. Current black sea bass stock assessments and fishery management plans assume a 15% discard mortality rate for the coastwide, year-round black sea bass recreational fishery. Based on our results, we recommend further evaluation of the appropriateness of this assumption in terms of being able to provide the best possible estimate of total fishery removals and for developing management plans. Because swim bladder venting was the single greatest factor that reduced the discard mortality rate and increased submergence success, fishery managers might consider encouraging, or even mandating, the venting of black sea bass released in offshore and deep water winter recreational fisheries. Yet, as previously stated, this would require extensive education of fishery participants on proper venting technique and tools. Additionally, given that predation events by other fishes primarily occurred early in our field season and that deeper depths had to be fished to catch black sea bass later in the winter, it may be most advantageous to open the fishery in our study areas off southern New Jersey from the period of mid- or late-December through January, which is when fish are more likely to be accessible at 'shallower' depths (i.e., <~55 m) and predation risk is lower. The results of our study are also applicable to other deep water regional fisheries in which black sea bass experience barotrauma, and therefore should assist with the development of regulations that would reduce the number of discards and discard mortality of black sea bass.