Swim Bladder Deflation In Black Sea Bass And Vermilion Snapper: Potential For Increasing Post Release Survival

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Swim Bladder Deflation in Black Sea Bass and Vermilion Snapper: Potential for Increasing Postrelease Survival

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Abstract.—Although some anglers regularly deflate swim bladders of demersal fishes being released, it is not known whether this practice actually increases postrelease survival of reef fishes. Benefits of deflating the swim bladder of black sea bass *Centropristis striata* and vermilion snapper *Rhomboplites aurorubens* before release were evaluated; survival of fishes deflated with one of two tools was compared to survival of nondeflated controls. Capture depths were 20–22 m, 29–35 m, and 43–55 m. Fishes were deflated with a 16-gauge hypodermic needle (99 black sea bass, 64 vermilion snapper) or with a Sea Grant tool consisting of a sharpened stainless steel *canula* (119 black sea bass, 64 vermilion snapper). Deflated fish were held in cages and observed in situ for 24 h. Controls (108 black sea bass, 89 vermilion snapper) were first segregated in a live well and then held in situ for 24 h in cages. Deflation, especially with the hypodermic needle, provided very significant reductions in mortality of black sea bass, and benefits of deflation increased with capture depth. Deflation for vermilion snapper was also beneficial, but to a lesser extent. Comparison of control results with a previous study using identical methods suggests that ascent speed may affect survival. Deflation of black sea bass and vermilion snapper by hypodermic needle is recommended for scientists. For anglers the Sea Grant tool may be a better choice; it is commonly used to apply dart-type tags and is readily available from some natural resources agency's tagging programs. Because the results differed for the two species, further study is needed to determine whether to recommend deflation as a standard practice for all reef fishes.

Many species in the reef fish fishery along the Atlantic coast of the southeastern USA are overfished (SAFMC 1997). In an attempt to eliminate or reduce overfishing, size or creel limits have been established for some species, including black sea bass *Centropristis striata* and vermilion snapper *Rhomboplites aurorubens* (McGovern et al., in press). Depite being overfished, these species continue to be among the more abundant reef fishes, and relatively large numbers of individuals that are undersize or in excess of creel limits are released by commercial and recreational anglers.

Many reef fishes, including black sea bass and vermilion snapper, captured from depths greater than about 20 m often exhibit difficulty submerging upon release and may experience various anatomical traumas due to decompression experienced during the rapid ascent associated with capture (Rogers et al. 1986; Render and Wilson 1996). Although the subject has not been thoroughly studied, several investigations into the survival of demersal reef fishes captured from various depths have been conducted (e.g., Parker 1991; Gitschlag and Renaud 1994; Collins 1995; Wilson and Burns 1996; Collins, in press). Mortality of released reef fishes can be high, varying among species and depths, and a substantial component of that mortality can be due to the inability to submerge as a result of swim bladder overinflation. The objective of this study was to determine whether postrelease survival of vermilion snapper and black sea bass might be increased by deflating the swim bladder before release. Significant increases in survival would enhance the effectiveness of size and creel limits, thus assisting in recovery of stocks.

Recreational (including charter and headboats) and commercial fishermen are being encouraged to puncture the swim bladder or abdomen, or both, of reef fishes before release because this is believed to increase chances of survival (e.g., Florida Sea Grant 1995; Sport Fishing Institute 1991). Although deflated fish appear to descend more easily than nondeflated individuals, it has not been documented that the procedure actually increases the survival percentage of released reef fish. In fact, Render and Wilson (1996) concluded that deflation should not be encouraged for red snapper *Lutjanus campechanus* in the Gulf of Mexico. Gitschlag and Renaud (1994) concluded that there was no significant difference in survival of deflated and nondeflated red snapper held in cages at depth. How-

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ever, recompression from forced descent in cages may have increased survival of nondeflated individuals. Gotshall (1964) suggested that deflated rockfish *Sebastes* spp. experienced greater mortality than those that were not deflated. In contrast, burbot *Lota lota*, largemouth bass *Micropterus salmoides*, and yellow perch *Perca flavescens* all benefited from deflation (Lee 1992; Bruesewitz et al. 1993; Keniry et al. 1996; Shasteen and Sheehan 1997). Qualitative assessment of tag-return data from an ongoing reef-fish tagging program suggests that deflation can be a valuable tool, allowing mark–recapture studies of species or population segments that often occupy depths too great for survival without deflation (e.g., Collins et al. 1996; J. McGovern, South Carolina Department of Natural Resources, unpublished data).

Intuitively, fish that are able to descend after deflation have a greater chance of survival than undeflated fish that float at the surface. However, increased survival due to puncture deflation has not been documented for reef fishes. It is not always possible to determine in advance whether an individual will be able to descend, so some fish will inevitably be deflated unnecessarily. It is not known whether deflation significantly reduces the chances of survival for these fishes that would have been able to swim downward without deflation. Finally, the effects of deflation may vary among species and capture depths. Documenting the effects of deflation on reef fishes is critical, as deflating reef fishes before release has become a common practice.

Methods

Three depth zones southeast of Charleston, South Carolina, were sampled in the study using recreational fishing methods: 20–23 m (shallow), 29–35 m (mid), and 43–55 m (deep). All fishing was conducted from the 22 m R/V *Lady Lisa* with Penn Senator 6/0 high-speed reels, 1.5-m rods, and 23-kg test monofilament line. Terminal tackle consisted of 2-hook bottom rigs with 4/0 hooks, 23-kg test monofilament leader, and a bank sinker of 0.23–0.45 kg. Hooks were baited with cut squid *Loligo* spp. Four to six anglers fished while the vessel drifted over live-bottom areas chosen from a historical database of known reef locations.

The study used two treatment groups and a control group. During each sampling day, groups were processed sequentially with the first group selected randomly. One treatment group (119 black sea bass, 64 vermilion snapper) was deflated using the Sea Grant deflation tool, supplied by Florida Sea Grant, which consisted of a hollow stainless steel shaft, 3 mm in width and 3.8 cm long, mounted in a hollow wooden handle. This tool was identical to one used for dart-tag application. The sharpened *canula* was inserted through the body wall underneath the scales approximately 2.5 cm posterior to the base of the left pectoral fin. Application of pressure to the abdomen was seldom needed to effect deflation with this tool. The second treatment group (99 black sea bass, 64 vermilion snapper) was deflated with a 16-gauge hypodermic needle inserted into the same location as described above. Unlike the Sea Grant tool, it was often necessary to apply pressure to the abdomen to achieve deflation. To limit other sources of variation, one person deflated all fish throughout the study.

Processing of the control group (108 black sea bass, 89 vermilion snapper) was more complex because mortality had two components: immediate mortality and 24-h mortality. Anglers dropped control fish into a 1-m^3 live well, which was equipped with flow-through seawater, and observed the behavior of the fish. Fish that swam to the bottom of the live well, which usually occurred immediately or not at all, were considered potential survivors and were tested for 24-h mortality using the same methods described for the treatment groups. Based on Collins (1995) and Collins (in press), these fish would have been able to swim to the bottom if released. Fish that floated at the surface were removed and counted as immediate mortalities.

After processing, fish were placed in weighted, 1.0-m diameter, 0.75-m high cylindrical cages of 1.27-cm-square plastic mesh braced with polyvinyl chloride (PVC) pipe. Numbers of fish per cage depended on sizes of the fish in each sample. Maximum biomass per cage was 3 kg based on biomass estimates of the chief scientist. For controls, only fish that swam to the bottom of the tank were caged. Cages were attached to lines and numbered buoys and were deployed in the same area and depth zone of their capture. After approximately 24 h, cages were retrieved, the conditions of the fish were assessed, and fish were measured (total and standard lengths, fork length when appropriate).

The effects of capture depth and deflation treatment on survival were examined with the RXC test of independence (Sokal and Rohlf 1981). Survival results were summarized in contingency tables for species pooled and by species for those with adequate sample sizes. The overall effects of depth and treatment were examined with two ×

TABLE 1.—Percent survival at three depths and sample size (N) of reef fishes captured with hook and line (manual reels) and either deflated with one of two tools (hypo = 16-guage hypodermic needle, Sea Grant = sharpened 3-mm-diameter stainless steel canula with wooden handle) or treated as controls (total mortality of controls = mortality due to floating + mortality in cages; separated fish that floated in onboard tank, caged fish that submerged at capture depth for 24 h).

	20–23 m			29–35 m			43–55 m		
Species	Control	Hypo	Sea Grant	Control	Hypo	Sea Grant	Control	Hypo	Sea Grant
Black sea bass	85 (32)	100 (19)	100 (39)	88 (51)	96 (69)	93 (60)	61 (25)	100 (11)	85 (20)
Vermilion snapper				100 (20)	100 (12)	100 (5)	82 (69)	90 (52)	95 (59)

three contingency tables summarizing survival results with depths pooled or treatments pooled. In separate contingency tables, the effect of depth was examined for each treatment, and the effect of treatment for each depth. The G_{adj} was generated for each contingency table using Williams' correction. Because the chi-square distribution closely approximates G_{adj}, a P-value was derived with appropriate degrees of freedom from the chi-square table. When significance was indicated, the data were disaggregated into three, 2×2 tables to compare survival between each pair of depths and between each pair of treatments (Zar 1984). The effect of fish length on survival was examined using the Kolmogorov–Smirnov test (Siegel 1956). In all tests, the null hypothesis was rejected when $P < 0.05$.

Results

Initial penetration was more difficult with the Sea Grant tool than with the hypodermic needle, and more care was therefore required to prevent overpenetration. On the other hand, deflation was much more rapid with the Sea Grant tool than with the hypodermic needle, abdominal compression was rarely needed, and clogging was less frequent.

Twenty-four cages were deployed in the shallow, 24 cages in the mid, and 26 in the deep zones. Soak times for all 74 cages closely approximated 24 h. Black sea bass mortality was consistently higher for controls than for deflated fish (Table 1). However, the differences were not significant in the mid depth. Mortality was significantly greater for controls than for either the hypodermic or Sea Grant tool treatments when depths were pooled ($P < 0.001$ and $P < 0.005$, respectively) and in the shallow depth zone ($P < 0.05$ and $P < 0.025$). In the deep zone, mortality was significantly greater for controls than for the hypodermic treatment ($P < 0.005$), but not the Sea Grant tool. Among controls, mortality was significantly greater in the deep than in the mid ($P < 0.01$) or shallow ($P < 0.05$) zones. For fish deflated with the Sea Grant tool, mortality was significantly greater in the deep than shallow zone ($P < 0.025$). There were no significant differences in mortality among depth zones for fish deflated with the hypodermic needle.

Vermilion snapper did not occur in the shallow zone, but were relatively abundant in mid and especially deep zones. There were no mortalities in the mid depth, and although percent mortality was somewhat higher for controls than for deflated fish in the deep zone, there were no significant differences (Table 1). However, mortality was significantly greater in the deep than mid zones for controls ($P < 0.05$), but not for deflated fish. Results of Kolmogorov–Smirnov tests indicated that mortality was not related to fish length for either species.

Discussion

Deflation, especially with the hypodermic needle, provided very significant reduction in mortality of black sea bass. Deflation was also beneficial, but to a lesser extent, for vermilion snapper. For mark–recapture studies conducted by scientists, the hypodermic needle is recommended. However, the advantages of using a hypodermic needle may be minimal for recreational and commercial anglers. Many anglers already carry a tool similar or identical to the Sea Grant tool because some state natural resources agencies supply tagging kits that include a tagging canula of the same design. In addition, the Sea Grant tool is larger and less likely to cause accidental injury to anglers. Further, deflation is rapid with this tool; this is desirable to both commercial and recreational anglers, who are often hurried, and may be advantageous to the fish when deflation takes place under less than optimal conditions (e.g., on a hot deck).

Mortality tends to increase with depth, as do the benefits of deflation. Survival in the deep zone increased from 61% for controls to 100% for hypodermically deflated black sea bass. Whether those benefits are greatly diminished over longer periods is not known, but 90% of mortality in red snapper occurred during the first 24 h (Gitschlag and Renaud 1994). Mortality of black sea bass was generally greater than that of vermilion snapper, but the benefits of deflation, especially with the hypodermic needle, were also greater. A previous study conducted during 1989–1991 in similar depth zones with the same tackle and same procedures as those used for controls in the present study also found that mortality increased with depth and that vulnerability to release mortality varied among species (Collins, in press). In addition, despite using almost identical methodology, mortality of black sea bass and vermilion snapper reported by Collins (in press) appeared substantially greater than in our study. An explanation is that anglers in the previous study were avid, experienced fishermen, while many of those in our study were less experienced. Experienced reef-fish anglers tend to fish more aggressively, landing fish as quickly as possible, and the resulting increase in ascent speed may account for the greater mortality observed in 1989–1991.

The methods we used to separate floaters from swimmers for the controls and to hold control and treatment fish at depth were evaluated thoroughly by Collins (in press). Divers evaluated conditions of caged fish before cage retrieval to determine whether evaluations after retrieval were biased by the ascent. Preretrieval and postretrieval evaluations were identical. The validity of separating floaters from swimmers in a 1-m-deep tank was examined by releasing 637 individuals of 17 species and observing them for 1 min or until they swam from sight. Results were compared with those from the tank, and it was found that separation in the tank was accurate for all species except black sea bass. Separation in the tank underestimated the percentage of black sea bass that floated in the mid and deep zones because some were able to swim down 2–4 m but then floated back to the surface and remained there. Thus, the survival percentages for black sea bass controls in our study are probably overestimates, and the benefits of deflation are therefore greater than indicated by the data.

Deflating the swim bladder of black sea bass before release significantly increases chances of survival over the first 24 h. Deflation is beneficial, but less so, for vermilion snapper. Whether deflation is beneficial in a given situation probably depends upon a number of factors, including species, capture depth, and ascent speed. We recommend deflation before release for black sea bass, but additional study is needed to determine whether to recommend deflation to anglers as a standard practice for reef fishes in general.

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