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Short communication

Large circle hooks and short leaders with fixed weights reduce incidence of deep hooking in angled adult red drum

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Abstract

We report on results of a multi-year study involving test fishing for large adult red drum *Sciaenops ocellatus* to determine the influence of hook style, circle hook size and leader-weight configurations on the incidence of deep hooking. We found a lower probability of deep hooking with circle hooks compared to similar terminal tackle fitted with J-style hooks. This result reinforces the notion that circle hooks, by virtue of the shape of the shank and the orientation of the hook point, are less likely to lodge in soft tissue deep in the throat. The lowest incidence of deep hooking (4%) was achieved using large or intermediate size circle hooks on short leaders with fixed weights. In addition, we found deep hooking probability to be reduced with a shortened length of leader with a fixed weight, regardless of the style of the hook. We infer from these latter results that large circle hooks are less likely to pass beyond the pharyngeal teeth into the throat after ingestion of bait. We also infer that a short length of leader with a fixed weight results in more immediate opposing pressure following ingestion, effectively dragging the hook into the corner of the mouth at the time the hook is set. These factors appear to work together to reduce overall likelihood of deep hooking. We encourage managers to promote the use of large circle hooks configured with short leaders and fixed weights to reduce deep hooking to achieve conservation goals established for the red drum catch-and-release fishery.

Keywords: Red drum; Circle hooks; J-style hooks; Deep hooking; Hooking injury; Catch-and-release; Recreational fishing

1. Introduction

While the use of circle hooks have been touted as a method to reduce the incidence of deep hooking in recreational fisheries, very few rigorous studies have been conducted to determine their efficacy. This point has been emphasized in recent reviews on the subject (Muoneke and Childress, 1994; Lucy and Studholme, 2002; Cooke and Suski, 2004). Further, it has been shown that many factors can affect the performance of terminal gear, and results tend to be species-, and sometimes age- or size-specific (Cooke and Suski, 2004). Deep hooking can cause internal injuries and excessive bleeding that can result in physiological stress

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leading to sublethal effects including reduced growth (Muoneke and Childress, 1994; Cooke et al., 2002). In addition, many studies highlighted in the reviews cited above have found deep hooking associated with elevated rates of release mortality in a variety of fishes.

The prevalence of deep hooking has become a focus of red drum *Sciaenops ocellatus* fisheries management in the southeastern US and Gulf of Mexico (Jordan and Woodward, 1992). Commercial and recreational take of red drum has been curtailed sharply in recent years as a conservation measure, and catch-and-release fishing practices have become increasingly common. Much of the management effort directed at red drum has now focused on protecting the spawning population; commercial harvest of large adult fish has been prohibited and recreational anglers are required to release all fish over a given length limit. Therefore, we feel it is imperative to investigate the hooking performance of different styles of terminal tackle that could help reduce the incidence of deep hooking and be readily adopted by conservation-minded anglers.

Here we report on 4 years of recreational fishing data to test the hypothesis that circle hooks reduce the incidence of deep hooking relative to J-style hooks. We compare the hooking performance of three different circle hook sizes to a single size J-style hook while controlling for the effect of the configuration of the terminal leader and weight.

2. Methods

We conducted test fishing for red drum during 1999–2003 in the lower Neuse River estuary in Pamlico and Carteret Counties in eastern North Carolina, USA. All red drum were captured from a small outboard fishing vessel anchored in 2–6 m of water during the summer and early fall. All fishing was supervised by the lead author. Multiple (4–7) unattended rods were fished simultaneously. Terminal tackle included Gamakatsu 7/0 octopus hooks (Style: 02417, hereafter referred to as J-style), Eagle Claw 8/0 circle hooks (Style: L2004EL), and Mustad 14/0 and 16/0 circle hooks (Style: 39960D, Fig. 1). We selected the 7/0 J-style hook as our standard treatment based on the fact that it is the most commonly used hook type in the fishery, determined through a mail-in survey sent to anglers in the region (L. Paramore, North Carolina Division of Marine Fisheries, and J. Bahen, North Carolina Sea Grant, unpublished data). For our study, hooks were baited with similar sized pieces (ca. 5 cm thick) of striped mullet *Mugil cephalus* cut through the transverse plane (head and tail section excluded). Hooks were configured with either a fixed 85.0 g (3 oz.) egg-shaped weight with a 0.15 m (6 in.) leader (hereafter referred to as a short leader with fixed weight configuration) or a sliding 56.7 g (2 oz.) egg-shaped weight with a 0.5 m (18 in.) long leader (hereafter referred to as a long leader with slide weight configuration). All of these terminal configurations consisted of 36.3 kg (80 lb) test monofilament leader connected to 9.1–13.6 kg (20–30 lb) test line by a 45.4 kg (100 lb) test barrel swivel (Fig. 1). The weights on the fixed weight configuration were flanked with plastic beads and steel crimping sleeves to secure the weight in place (Fig. 1). The terminal tackle was cast from the boat, slack was taken up and the rod was secured in the rod holder until evidence of a strike. When a strike was detected, the rod was picked up and the reel was wound until the fish was hooked securely. The same hook-up method was used regardless of the style of hook or leader configuration. The drag on the reel was set at approximately 1.4–2.3 kg (3–5 lb) off the rod tip.

Following landing, fish were classified as either shallow or deep hooked. The shallow hooked classification included hook piercing positions located on the maxilla and tongue, while all fish with hooks lodged posterior to the pharyngeal teeth were classified as deep hooked. The recreational catch in this boat fishery is composed mostly of large, mature red drum (mean fork length measured during 2000 and 2001 was 105.2 and 106.9 cm, respectively, R. Aguilar, Smithsonian Environmental Research Center, Edgewater, MD, unpublished data). Some smaller, juvenile fish are captured occasionally in the fishery. To minimize the potentially confounding effect of fish size, we restricted our analysis to fish 90 cm fork length and greater (a size class that represented more than 94% of the total catch during the years of our study). The North Carolina Division of Marine Fisheries has established a slot limit for this species, prohibiting the possession of any fish larger than 68.58 cm TL (27 in TL). Thus, the state mandates that all the fish of the sizes handled in this study must be released after capture in an effort to rebuild spawning biomass.

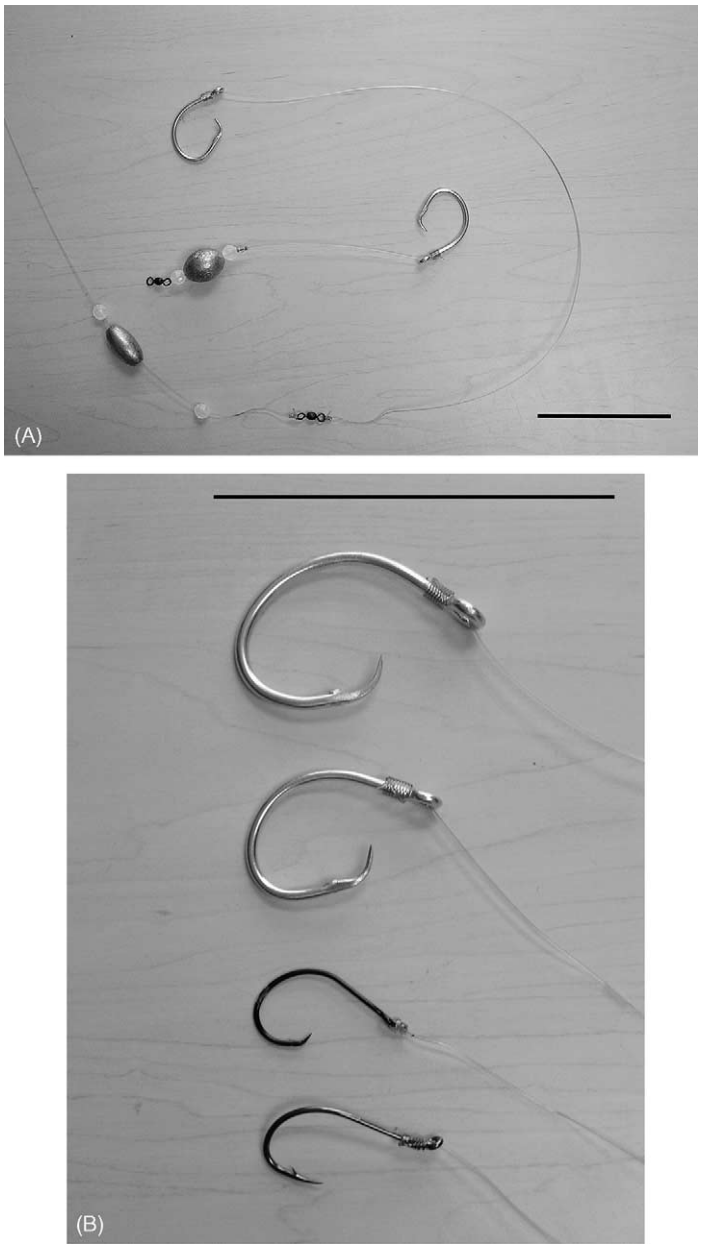

Fig. 1. Images of (A) the two leader types and (B) the four hook types used in the study. The two leader types shown are the short leader with fixed weight (appearing in the middle of the image), and the longer leader with a slip weight (each shown attached to a 14/0 Mustad circle hook). The four hooks shown (from top to bottom) are a 16/0 Mustad circle hook, a 14/0 Mustad circle hook, an 8/0 Eagle Claw circle hook, and a 7/0 Gamakatsu J-style hook. The bar appearing in both images is 10 cm.

The study was designed to investigate the incidence of deep hooking by applying different treatments of terminal tackle during test fishing trials. Specifically we quantified the probability of deep hooking using the three different sizes of circle hooks described above compared to our standard 7/0 J-style hook treatment while controlling for the leader and weight configuration. In each year of the study with the exception of 2003, we fished two different hook treatments (a particular size circle hook and a 7/0 J-style hook) with approximately equal effort controlling for the leader and weight configuration. We consider each hook style as a separate treatment in this analysis, and the fishing trial outcome as either shallow or deep hooking. We applied the Yates corrected chi square test to determine if the treatments differ in their probability of deep hooking. For each year during 1999–2001, we compared the performance of a large circle hook (16/0) to the 7/0 J-style hook configured with long leaders and a slide weight. During 2001–2002 we compared the performance of two different size circle hooks (small, 8/0 and intermediate, 14/0) to the 7/0 J-style hook configured with a short leader and a fixed weight. Finally, in 2003, we documented the performance of a single size circle hook (14/0) configured with a long leader and a slide weight (here we assumed the control treatment were the trials conducted during 1999–2001 using the 7/0 J-style hook with the same long leader and slide weight configuration). To isolate the effect of the leader length and weight configuration, we considered leader-weight configuration as a treatment and pooled trial results over years for terminal tackle fitted with either 7/0 J-style hooks (years 1999–2001 for long leader and slip weight configuration versus years 2001–2002 for short leader and fixed weight configuration) or intermediate size (14/0) circle hooks (year 2002 for short leader and fixed weight configuration versus year 2003 for long leader and slip weight configuration). All statistical tests were conducted using SPlus 6.0 (Insightful Inc.).

3. Results

We found that hook style, circle hook size and the leader-weight configuration had an influence on the incidence of deep hooking in our test fishing trials. Our results from test fishing with long leaders with slide weights during 1999–2001 and 2003 revealed that intermediate and large circle hooks can reduce the deep hooking probability relative to 7/0 J-style hooks (Table 1). We detected a significant treatment effect with the terminal gear fitted with a large circle hook (proportion deep hooked = 0.11 during 1999, 0.12 during 2000 and 0.04 during 2001, all at $P < 0.05$). Our test fishing with long leaders and slide weights during 2003 indicated that intermediate size circle hooks can result in significantly lower probability of deep hooking, albeit not as low as that observed for large circle hooks (0.22 during 2003, $P < 0.05$). Our test fishing with short leaders and fixed weights during 2001–2002 revealed that large but not small circle hooks can reduce the incidence of deep hooking relative to J-style hooks. The proportion of deep hooked fish were lower in the

Table 1
Summary of test fishing trials conducted during 1999–2003. With the exception of 2003, test fishing each year consisted of matched leader-weight configurations fitted with either a 7/0 J-style hook or one of three different sizes of circle hooks

Year	Hook type	Hook size	Leader	Total N	Shallow	Deep	Proportion of deep hooked
1999	J-style	7/0	Long/slip	58	26	32	0.55
1999	Circle	16/0	Long/slip	18	16	2	0.11*
2000	J-style	7/0	Long/slip	55	27	28	0.51
2000	Circle	16/0	Long/slip	84	74	10	0.12*
2001	J-style	7/0	Long/slip	88	42	46	0.52
2001	Circle	16/0	Long/slip	24	23	1	0.04*
2001	J-style	7/0	Short/fixed	24	19	5	0.21
2001	Circle	8/0	Short/fixed	47	43	4	0.09
2002	J-style	7/0	Short/fixed	42	31	11	0.26
2002	Circle	14/0	Short/fixed	244	235	9	0.04*
2003	Circle	14/0	Long/slip	158	124	34	0.22*

* Significant hook type treatment effect.

trials involving both size circle hooks, but a significant treatment effect was only found in the trials involving the large circle hook (proportion deep hooked = 0.04 during 2002, $P < 0.05$).

We found a significant reduction of deep hooking in trials using short leaders with fixed weights (Table 1). We found the probability of deep hooking with 7/0 J-style hooks was reduced by a factor of two owing to a shortened length of leader with a fixed weight (proportion of deep hooking 0.53 versus 0.24, $P < 0.05$). The use of a short leader with a fixed weight and intermediate size circle hooks reduced deep hooking incidence by a factor of five (0.22 versus 0.04, $P < 0.05$).

4. Discussion

By way of regulations and a changing ethos among anglers, catch-and-release practices are becoming increasingly common in today's recreational fishery. To reduce the negative impacts of recreational fishing, efforts have been underway to design terminal tackle that reduces trauma to hooked fish. Unfortunately, there have been few studies that have investigated the efficacy of different configurations of terminal tackle. Here we report that a common objective of reducing impacts of the recreational fishery on large red drum can be achieved simply through promoting certain styles of terminal gear. Consistent with other studies, we found reduced incidence of deep hooking with the use of circle hooks compared to J-style hooks (see review by Cooke and Suski, 2004). This result is due likely to the shape of the shank and the orientation of the hook point, which results in a lower probability that the hook point lodges in soft tissue deep in the throat. We extended this general result in the present study by further examining the influence of circle hook size and the effect of the leader-weight configuration. Here we found the incidence of deep hooking can be reduced by an order of magnitude by using large circle hooks configured with a short leader with a fixed weight. We infer from these results that large hooks are less likely to pass through the gullet after ingestion of bait and a short length of leader with a fixed weight results in more immediate opposing pressure, effectively dragging the hook toward the corner of the mouth at the time of hook set. Based on our results, both of these factors appear to work together to reduce the overall likelihood of deep hooking.

We feel our results are likely to apply generally for fishers targeting species of similar sizes from anchored boats in coastal river mouths and sounds exhibiting slow moving currents. The lack of current and resulting side-to-side movement (or sway) of an anchored boat can lead to slack in the fishing line, and this may be an important factor increasing the likelihood of deep hooking. We feel our short leader with the fixed weight configuration resulted in more tension on the leader at the time of bait ingestion, thus reducing the likelihood that the hook point would become lodged deep in the throat. Anglers fishing from shore in tidal inlets and marine systems with more active currents report a lower incidence of deep hooking overall (L. Paramore, NCDMF, personal communication). While the environmental factors that influence deep hooking was not the focus of this study, we recommend further research to investigate the role currents (or perhaps other "extrinsic factors") can play in defining the likelihood that hooks will lodge deep following bait ingestion. It is not clear whether these results hold for smaller fishes, and we feel it would also be worthwhile to address these issues in a separate study.

The authors promote the use of this terminal tackle to achieve the conservation objectives for rebuilding stocks of red drum in the US southeast Atlantic coast and throughout the Gulf of Mexico. The results may apply more broadly across many different species, but efforts should be undertaken to conduct the rigorous studies necessary to determine whether our results can be generalized.

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