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Performance of Barbed and Barbless Hooks in a Marine Recreational Fishery

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Abstract.—We used an angling study to examine catch per unit effort (CPUE), bait loss, and total landings by anglers fishing with natural bait on barbed and barbless hooks in a nearshore marine sport fishery located in the Gulf of Mexico near St. Petersburg, Florida. Anglers fished half the day with a barbed hook and half the day with a barbless hook. We also recorded anatomical hook placement, severity of injury or bleeding, and hook extraction times for each landed fish. Bait loss, CPUE, and mean length of catch did not differ between gears, but anglers landed 22% more fish with barbed hooks. Loss of hooked fish was significantly higher with barbless hooks, and efficiency appeared to vary among species. Mean unhooking times were significantly shorter with barbless hooks. Anatomical hook placement did not differ between gears and most fish were hooked in the jaws. Bleeding did not differ between gears because bleeding was influenced strongly by hook placement, but barbless hooks reduced unhooking injuries. In this fishery, barbless hooks probably did not reduce hooking mortality and conferred only slight benefits at the expense of reduced catches.

Compared with barbed hooks, barbless hooks are one fishing method thought to reduce hooking mortality by reducing handling time, stress, and trauma. Most previous evaluations of barbless hooks have focused on comparisons of hooking mortality in salmonids, and authors have disagreed over the effectiveness of barbless hooks in improving postrelease survival (Milne and Ball 1956; Hunsaker et al. 1970; Falk et al. 1974; Falk and Gillman 1975; Titus and Vanicek 1988; Taylor and White 1992, 1997; Gjernes et al. 1993; Muoneke and Childress 1994; Schill and Scarpella 1997; Turek and Brett 1997).

One issue that has been largely overlooked in the barbed versus barbless debate is the effect of hook type on angler catch. That is, if barbless hooks were promoted or required, would anglers expect any differences in catch rate, fish size, or species composition of their catch? As with studies of hooking mortality, previous studies of hook efficiency have focused on salmonids. Butler and Loeffel (1972) reported slightly higher catches of coho salmon *Oncorhynchus kisutch* on barbed versus barbless hooks in a commercial troll fishery, but there were no catch differences for chinook salmon *O. tshawytscha*. Knutson (1987) found no differences in efficiency between barbed and barbless hooks in a charter-boat fishery targeting coho and chinook salmon, but barbless flies increased loss rates of juvenile and adult steelhead *O. mykiss* (Barnhart 1990). Efficiency of barbed and barbless hooks in other fisheries has not been evaluated.

We conducted a controlled study of angler catches in a nearshore mixed-species marine recreational fishery in the Gulf of Mexico. Utilizing volunteer anglers fishing with baited barbed and barbless hooks, we compared their catch rates, total landings, bait loss, and unhooking times. We also compared hook placement (i.e., hooking location), injury, and bleeding among fish to determine if barbless hooks shortened unhooking times or caused fewer injuries to fish.

Methods

Each volunteer participated in only one trip. Anglers were told that they would be participating in a fishing study but were not provided details of study design. Nearly all anglers had limited fishing experience, so the design was not stratified and all anglers were pooled.

Most fishing was carried out in the vicinity of an artificial reef consisting of a sunken barge located about 10 km west of St. Petersburg, Florida, in water depths ranging from 8 to 20 m. We used two distinct fishing strategies: drifting over rock ledges in calm weather, and anchoring on artificial reefs during rough weather. Decisions regarding fishing strategy were weather dependent and designed to maximize catch and minimize motion sickness among volunteers. We assumed no differences in gear efficiency among strategies and therefore pooled the data for analysis.

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Each trip consisted of two discrete fishing periods lasting 1.0–1.8 h. We fished one morning period between 0900 and 1200 hours and one afternoon period between 1300 and 1700 hours. Volunteers were assigned identical rods and spinning reels loaded with 10-kg monofilament. Terminal tackle consisted of an 84-g lead weight, a 30-cm leader of 30-kg monofilament, and a single Mustad 3407 3/0 hook. Half the volunteers were randomly assigned barbed hooks, the others a barbless hook. Barbless hooks were prepared by flattening barbs with pliers, and all hooks were sharpened before use. Bait was freshly thawed squid *Loligo* spp. cut to a uniform size of 2 cm × 2 cm. Anglers were instructed to fish near the bottom without assistance from the crew. We recorded hook type, rate of bait loss, loss of hooked fish, and number of fish landed by each angler. Samples were terminated when volunteers became inattentive, which often occurred after about 1 h of fishing. At the beginning of the second fishing period, we switched gears so that each volunteer fished with both hook types during the day.

Anglers landed all fish by lifting them into the boat, except for sharks and stingrays (Dasyatidae) that were released by the researchers. We recorded hook location and unhooking time for each landed fish and evaluated bleeding and injuries immediately after hook extraction while fish were being identified and measured (mm). Bleeding intensity was defined as minimal (no bleeding, or presence of insignificant amounts of blood), moderate (light to moderate flow), or severe (copious or continuous flow). Injuries were defined as minimal (the only trauma was a simple puncture wound), moderate (some tearing or laceration of tissue), or severe (tearing or laceration severe enough to impair anatomical function). Bleeding and injury levels designated by the two researchers were made as consistent as possible by in-field comparisons of independent assessments. After evaluation, fish were released immediately. Because most fish dived for the bottom and were lost from sight quickly, we did not quantify mortality.

Differences in means were tested with analysis of variance (ANOVA) or, where ANOVA assumptions were violated, with Wilcoxon's rank-sum test. Differences among distributions were tested with Kolmogorov–Smirnoff tests (Conover 1999); chi-square tests were used to evaluate differences in hook placement, injury, and bleeding. Sampling periods varied in length, so bait loss, loss of hooked fish, and landings were converted to hourly rates by dividing results by time expended during each sample. Because results in the second sample may have been conditional on the first sample and not independent, we analyzed each variable by dividing anglers into two groups: those that began fishing with barbed hooks, and those that began fishing with barbless hooks. We then calculated differences between morning and afternoon fishing periods for each angler within each group (barbed minus barbless) and tested the hypothesis of no difference between groups. This approach also accounted for potential differences between morning and afternoon fishing periods. All analyses were performed using SAS statistical software (SAS Institute 1998) with $\alpha = 0.05$.

Results

The 42 volunteer anglers fished with barbed hooks for a combined 53.6 h and barbless hooks for 53.3 h during seven fishing trips in 1996 and 1997 (Table 1). There were no statistically significant differences in bait loss or catch per unit effort (CPUE) between barbed and barbless hooks (Wilcoxon's rank-sum tests). However, there was a significant difference in numbers of fish landed by individual anglers: means of 6.0 fish for barbed hooks versus 4.9 fish for barbless hooks (Table 1). Barbless hooks allowed significantly more loss of hooked fish.

Anglers landed 479 fish representing 15 species (Table 2). Sand perch and blue runners were the most abundant species captured, composing about 62% of total catch. Grunts and gray triggerfish were also common, whereas preferred game species, such as red grouper, were rare. Mean lengths of captured fish did not differ significantly (ANOVA) among hook types; nearly all captured fish were less than 350 mm. Total landings using barbless hooks were 22% lower than barbed hooks, probably because barbless hooks allowed more hooked fish to escape (Table 1) and captured significantly fewer gags and blue runners (chi-square; Table 2).

Anglers had little information about the study design and occasionally unhooked or released fish before we were able to collect data. Consequently, sample sizes for hook placement, unhooking times, injury, and bleeding were slightly smaller than total catches.

Anglers unhooked fish caught with barbless hooks faster than those taken on barbed hooks; differences were more pronounced for larger species, such as red grouper and black sea bass that tended to engulf baits (Table 2). A mean of 16.1 s was needed to unhook a fish captured with a

TABLE 1.—Sampling dates (1996–1997), number of anglers, duration of fishing period (h), fishing strategy, number of fish landed, bait loss, escapement, and catch per unit effort (CPUE) for fish captured by anglers using barbed (B) or barbless (BL) hooks in the Gulf of Mexico near St. Petersburg, Florida.

Date	Number of anglers	Duration (h)	Strategy	Average catch landed per angler		Bait loss[a]		Number fish escaped[a]		CPUE[a]	
				B	BL	B	BL	B	BL	B	BL
1996											
Oct 26	8	1.8	Anchor	4.5	2.5	15.7	15.1	0.3	0.6	2.5	1.4
	8	1.5	Anchor	1.8	2.0	14.0	20.0	1.6	0.7	3.6	4.0
Nov 24	5	1.8	Drift	9.3	13.3	3.5	3.7	0.9	1.1	7.4	6.3
	5	1.7	Drift	11.0	11.5	3.6	4.6	0.7	0.9	6.6	2.5
1997											
Feb 8	7	1.0	Anchor	2.5	3.0	13.8	18.0	0.0	0.0	2.5	3.0
	7	1.0	Anchor	3.0	1.5	12.9	12.9	0.0	0.7	4.3	2.2
Feb 15	4	1.0	Anchor	4.0	4.0	20.3	20.7	0.0	1.0	4.0	4.0
	4	0.8	Anchor	4.7	6.3	3.8	2.9	0.0	1.3	5.8	7.9
Mar 15	6	1.0	Drift	4.5	1.3	4.0	3.0	0.5	1.7	4.5	1.3
	6	0.8	Anchor	3.0	2.0	2.3	6.5	0.0	0.0	3.0	2.0
Apr 6	4	1.0	Anchor	5.3	9.0	8.0	14.7	0.8	2.1	4.3	7.2
	4	1.0	Anchor	12.5	10.0	12.7	28.3	2.1	5.0	10.4	8.3
Jun 22	8	1.5	Anchor	7.3	3.0	2.5	4.3	0.2	0.3	4.8	2.0
	8	1.2	Anchor	9.5	6.3	4.4	6.6	0.2	1.4	7.6	5.0
Means		1.2		6.0	4.9	9.0	11.0	0.6	1.0	4.9	4.0

[a] Bait loss, escapement, and CPUE are expressed as mean number per h.

barbed hook compared with 6.6 s for a barbless hook (Table 2). Barbless hooks significantly reduced the frequency of long unhooking times; maximum unhooking time was reduced by 40% (Figure 1).

Hooking location in fish did not differ between hook types (chi-square). Most fish (80%) were hooked in the jaws, and 20% were hooked in sensitive areas (gills, throat, gut, or foul-hooked). Bleeding intensity did not differ significantly among gears (Figure 2) because bleeding was determined primarily by hooking location. Fish hooked in sensitive areas bled regardless of hook type. Barbless hooks significantly reduced injury. Injury was also influenced by hooking location, but barbless hooks significantly reduced the proportion of fish released with moderate or severe injury.

Discussion

Our results were consistent with previous studies reporting higher catch rates with barbed hooks (Butler and Loeffel 1972; Knutson 1987; Barnhart 1990). In our study, differences were more pronounced. Catch differences could have been the result of our fishing method or angler experience. Butler and Loeffel (1972) and Knutson (1987) sampled salmonid troll fisheries in which fish were hooked using tight line presentations by charter or commercial anglers, while Barnhart (1990) sampled guided fly anglers. Anglers in those studies were probably more experienced than our anglers. Furthermore, our terminal tackle allowed slack line presentations, and anglers had to detect strikes and hook fish themselves. However, larger differences in catch rates between hook types may have also been due to species-specific differences in hooking efficiency; we observed that barbless hooks seemed especially inefficient at capturing gags and blue runners, whereas efficiency differences for other species were either not significant or less pronounced.

Diggles and Ernst (1997) found that barbless hooks shortened release times, but release times in our study were much shorter, probably because the fish captured were smaller or easier to handle. Our release times were also shorter than those estimated for rock bass *Ambloplites rupestris* angled with barbless hooks and worms (Cooke et al. 2001), but in that study a greater proportion of fish were hooked in areas other than the jaws. Reduction in release times with barbless hooks may be specific to a fishery or to species within a fishery.

We assumed that anglers fished with equal intensity when using barbed and barbless hooks. This assumption may have been violated because gear assignment was not blind, and all anglers realized that they were evaluating the two hook types. Anglers may have been prone to the Hawthorne effect, which is a tendency for experimental subjects to exhibit the behavior they think the researcher is looking for (Rothman and Ericson 1987). Conse-

TABLE 2.—Species and numbers captured, percent change in landings, and mean unhooking times for fish captured by anglers using barbed (B) or barbless (BL) hooks in the Gulf of Mexico near St. Petersburg, Florida, 1996–1997.

Species name		Numbers captured		Change in landings with BL (%)	Mean unhooking times (s)	
Common	Scientific	B	BL		B	BL
Sand perch	*Diplectrum formosum*	109	89	−19	14.3	7.9
Blue runner	*Caranx crysos*	57	37	−35	13.5	3.9
Grunts[a]	*Haemulon* spp.	47	43	−9	17.9	6.4
Gray triggerfish	*Balistes capriscus*	18	18	0	20.0	5.5
Gag	*Mycteroperca microlepis*	13	2	−85	16.9	7.0
Pinfish[b]	*Sparidae*	9	8	−12	6.3	9.0
Red grouper	*Epinephelus morio*	4	3	−25	49.5	1.3
Southern puffer	*Sphoeroides nephelus*	3	3	0	17.3	16.7
Black sea bass	*Centropristis striata*	3	2	−33	69.6	1.1
Snappers[c]	*Lutjanidae*	2	3	50	9.0	3.0
Inshore lizardfish	*Synodus foetens*	2	1	−50	14.5	8.8
Southern flounder	*Paralichthyes lethostigma*	1	0	100	20.0	
Totals		268	209	−22		
Means					16.2	6.6

[a] Includes bluestriped grunt *Haemulon sciurus* and tomtate *Haemulon aurolineatum.*
[b] Includes pinfish *Lagodon rhomboides* and spotted pinfish *Diplodus holbrooki.*
[c] Includes lane snapper *Lutjanus synagris* and yellowtail snapper *Ocyurus chrysurus.*

quently, differences between hook types may have been confounded because of higher angler motivation when fishing with a particular hook type. Angler motivation clearly biased the time required to unhook fish. After anglers became aware that we were measuring unhooking times, they would secure landed fish and position themselves for hook extraction. This undoubtedly reduced unhooking times for both gears. Despite this, relative differences between hook types were significant and were consistent with our expectation that release times would be shorter for barbless hooks.

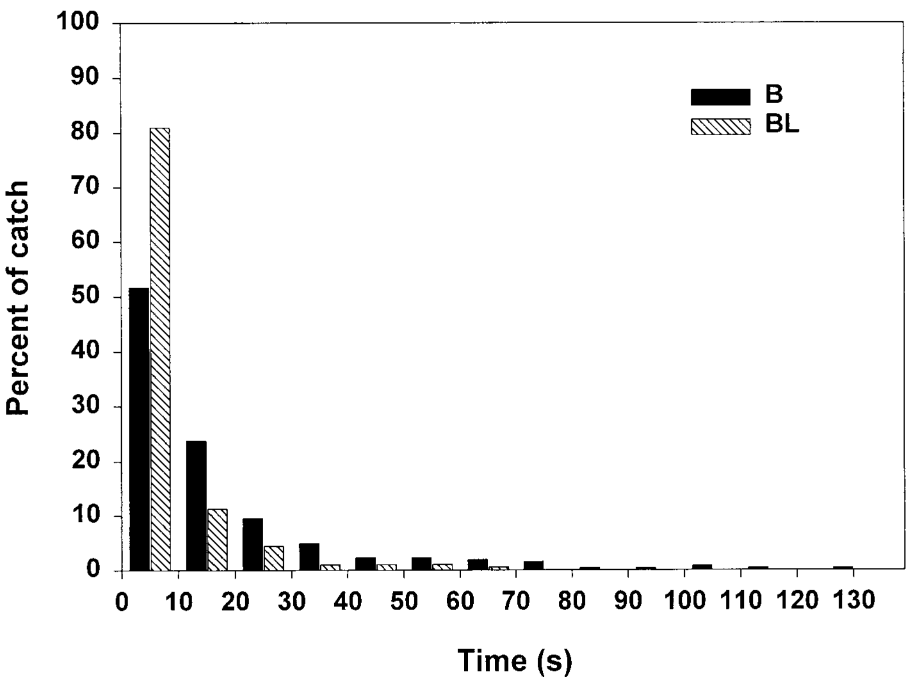

FIGURE 1.—Frequency of unhooking times for 479 fish captured with barbed (B) and barbless (BL) hooks in the Gulf of Mexico near St. Petersburg, Florida, 1996–1997. Bars depict percent of observations falling within each 10-s time interval.

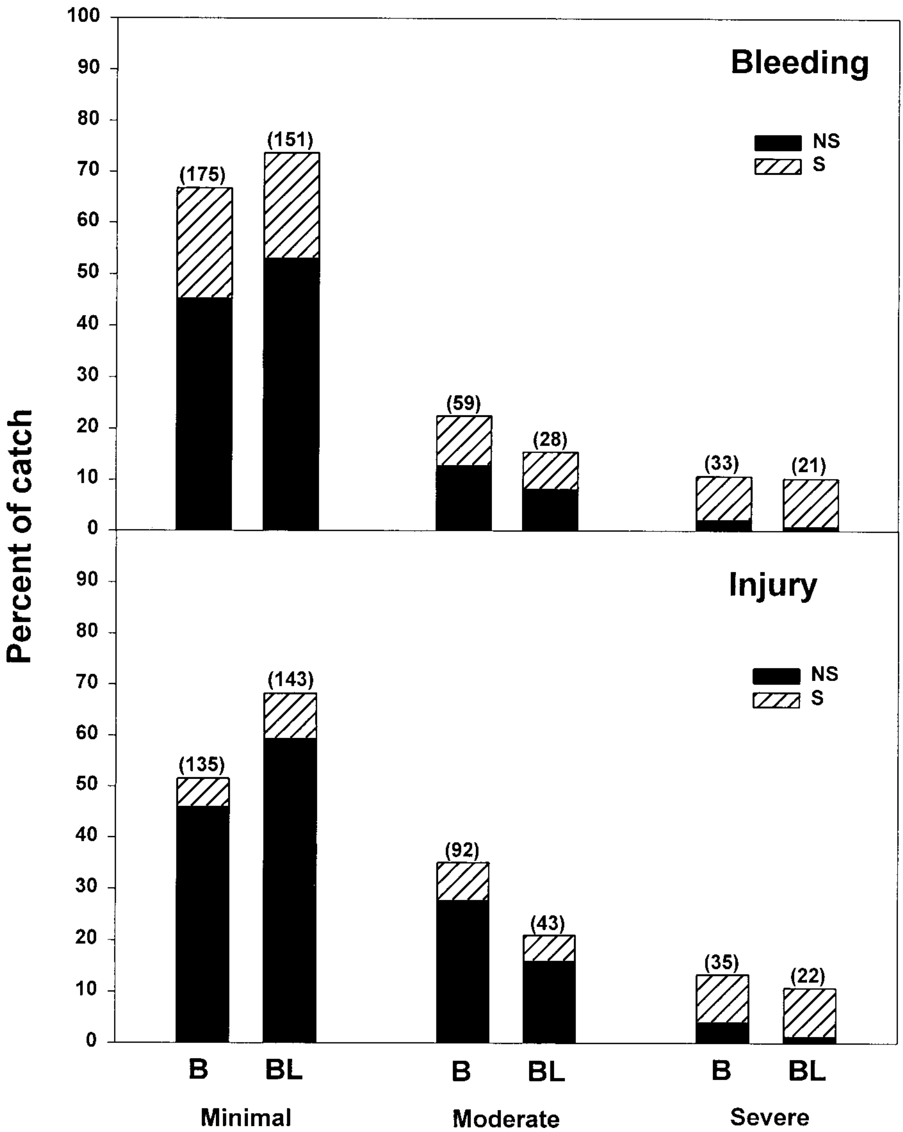

FIGURE 2.—Bleeding, injury, and hooking location (S = sensitive areas including gills, throat, gut, or foulhooked; NS = nonsensitive areas including upper and lower jaws) among fish captured with barbed (B) and barbless hooks (BL) in the Gulf of Mexico near St. Petersburg, Florida, 1996–1997. Percentages were calculated separately for each gear type. Sample sizes are in parentheses.

In the fishery we sampled, it is unlikely that barbless hooks reduced hooking mortality. Barbed and barbless hooks hooked fish in the same anatomical locations, and many studies have concluded that hook location is the primary factor regulating postrelease mortality across a variety of taxa and conditions (Falk et al. 1974; Falk and Gillman 1975; Warner 1979; Nuhfer and Alexander 1989; Gjernes et al. 1993; Muoneke and Childress 1994; Murphy et al. 1995; Schisler and Bergersen 1996; Taylor et al. 2001). Although barbless hooks shortened release times, most fish captured with barbed hooks were released quickly, and long release times generally occurred in fish that were hooked in sensitive areas after engulfing the hook. Those individuals may have been likely to die regardless of hook type. Furthermore, there is no consensus on whether shortened release times reduce hooking mortality. Removing fish from the water causes stress (Ferguson and Tufts 1992;

Cooke et al. 2001). Length of time out of water increased mortality of rainbow trout *O. mykiss* (Schisler and Bergersen 1996) and cardiac recovery time in rock bass (Cooke et al. 2001), but other authors reported that variation in handling had no effect on mortality (Hulburt and Engstrom-Heg 1980; Loftus et al. 1988). However, shortened release times associated with barbless hooks may improve survival of species that are extremely sensitive to handling, even when hooked in nonsensitive areas, and they may also reduce nonlethal effects (Cooke et al. 2001).

We caution against generalization of our results to other fisheries because samples were small and anglers used only one hook size and captured a narrow size range of fish. However, they lend support to the position that advantages of barbless hooks in bait fisheries may be slight, and not justifiable when catch reductions are considered. Instead of promoting particular hook types, managers might focus on angler education. Anglers can minimize hooking mortality by fishing with artificial lures large enough to prevent engulfment (Nuhfer and Alexander 1989) and by using tight line presentations when using bait (Schisler and Bergersen 1996). Both strategies have been shown to reduce critical hooking.

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