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# The Effect of Scented Lures on the Hooking Injury and Mortality of Smallmouth Bass Caught by Novice and Experienced Anglers

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*Abstract.*—Although regulations prohibiting the use of natural baits are relatively common, new regulations specifically targeting the use of chemical attractants have recently been implemented. While no citeable evidence for these new regulations exists, they may have been promulgated due to a perceived increase in the risk of fish mortality from scented lures compared with unscented lures. The present study investigated the hooking injury and short-term mortality of 238 adult smallmouth bass *Micropterus dolomieu* captured on Lake Erie by both experienced (fished > 100 d/year) and novice (fished < 10 d/year) anglers on actively fished jigs similarly threaded with minnows, nonscented plastic grubs, or grubs scented with chemical attractants. The depth of hook ingestion, the anatomical hooking location, the presence of bleeding at the hook wound, and the total amount of time taken to remove the hook were noted on all captured fish. The fish were then transferred to a retention cage, and their survival was monitored for 72 h before release. None of the fish captured suffered any immediate (<1 h) or short-term (<72 h) mortality. The type of bait used to capture the fish had no significant effect on the depth of hook penetration or the anatomical hooking location. More experienced anglers, however, hooked the fish significantly deeper in the mouth than the novice anglers. These results suggest that the use of the chemical attractants tested in the present study do not deleteriously affect the injury rates or survival of captured smallmouth bass. Therefore, regulations prohibiting the use of chemical attractants on actively fished single-hook jigs for smallmouth bass appear unjustified if the intent was to reduce hooking injury and mortality.

Due to increasing recreational and competitive fishing pressures, the quality of black bass fisheries *Micropterus* spp., as measured by larger catches or better catch rates, is dependent on the effectiveness of catch-and-release management strategies (Muoneke and Childress 1994; Quinn 1996). However, for this nonconsumptive angling to be successful, the released fish must survive the hooking and subsequent handling stress (Payer et al. 1989; Muoneke 1992). In addition to the potential immediate mortality due to physical angling injuries, released fish may also suffer delayed mortality due to the effects of severe exercise incurred during angling (Wood et al. 1983) or other less immediate terminal injuries (Muoneke and Childress 1994).

Although the mortality of released fish can be related to several factors (see Muoneke and Childress 1994; Weathers and Newman 1997), wound severity relating to the use of various types of terminal gear has been implicated as a major cause of hooking mortality in smallmouth bass *M. dolomieu* (Clapp and Clark 1989), walleyes *Stizostedion vitreum* (Payer et al. 1989), and cutthroat trout *Oncorhynchus clarki* (Pauley and Thomas 1993). Relative to fish caught using artificial lures, those hooked with natural baits may suffer higher mortality rates resulting from deeper hook ingestion and the associated increased potential for greater handling stress and bleeding (Payer et al. 1989). Thus, terminal gear restrictions (such as artificial lures only) may be critical for the success of some catch-and-release management strategies in centrarchid (Clapp and Clark 1989), percid (Payer et al. 1989), and salmonid (Pauley and Thomas 1993) fisheries.

The soft plastics industry has expanded to meet an increased demand, especially in the black bass and walleye fisheries, for more effective artificial lures that mimic the color, style, and movement of natural bait. This industry also manufactures lures containing chemical attractants that are intended to cause fish, specifically black bass, to both approach the lure and hold it for a longer time, therefore giving the angler ample opportunity to detect the bite and set the hook (Quinn 1997). Although there are many examples of regulations that are designed to restrict the use of natural baits, only recently have regulations also targeted the use of chemical or scented substances (National Parks Fishing Regulations 1998). These regulations were

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implemented in many of Canada's national parks in which salmonids predominate. However, they were also implemented in Point Pelee National Park, which is a warmwater fishery largely predominated by centrarchids (T. Linke and R. Chiarot, Canadian Parks Service, unpublished). While no written explanation is provided for regulations specifically targeting the use of scented lures, they reflect a perceived concern over the increased risk of fish mortality from the use of scented lures rather than unscented lures. To date, the only study to investigate the effects of chemical attractants on hooking mortality found a higher hooking mortality associated with the use of scented artificial baits over artificial flies in rainbow trout *Oncorhynchus mykiss* (Schisler and Bergersen 1996). However, no studies have compared the use of scented artificial lures to natural baits, and none have examined these effects on centrarchids.

The purpose of this study was to compare the hooking mortality and hooking injury (e.g., bleeding, handling time, depth of hook ingestion, and anatomical location of hook penetration) among smallmouth bass captured by novice and expert anglers using natural baits, unscented lures, and chemically scented lures. Our primary objective was to examine the relationship between lure type and hooking mortality and hooking injury to test the hypothesis that mortality and injury of captured fish are not related to use of these terminal gear types in smallmouth bass. A secondary objective was to compare differences in angler abilities to explore the hypothesis that angler experience has no effect on the injury and mortality rates of captured fish.

## Methods

All fish used in this study were adult smallmouth bass angled between June 9 and June 16, 1999, on Lake Erie. Both novice (fished $<$ 10 d/year) and experienced (fished $>$ 100 d/year) anglers captured smallmouth bass on medium-action spinning rods and 6–8 lb test line. The terminal gear included ¼-ounce jig heads with a size-1 barbed bronze hook and a randomly chosen type of bait from a predetermined set of lure types. To compare the effect of chemical attractant on hooking injury and mortality, the fish were caught on single-hooks threaded with either dead minnows (emerald shiners *Notropis atherinoides*), Berkley Power grubs, salted plastic Yamamoto grubs, unscented plastic grubs that were completely immersed in oil of anise before each cast, or plain, unscented plastic grubs. Minnows were considered to be natural bait, and plain, unscented lures were the only unscented lures used. All other lures used in this study were grouped in the scented category. All lures and bait were approximately 4 in long and smoke in color, and all were threaded onto the hook through the main body of the lure or bait with the hook exiting just anterior to the tail. The tails were oriented downwards so that the soft plastic did not impinge on the hook and impede the swimming motion of the lure.

When fishing, the anglers stood on a shore that immediately dropped off into deep (approximately 7 m) water. The jigs were cast out and permitted to settle on semislack line until either a strike was detected or the line became taut. If a strike was detected the angler would set the hook in an upwards sweeping motion. If no strike was detected, the angler would raise and lower the rod tip slowly and reel in excess line. The process was repeated until either a strike was detected or the jig was too close to the angler. Once hooked, smallmouth bass were brought directly to the angler and landed within 30 s. One of seven anatomical hooking locations was recorded: upper jaw, lower jaw, roof of mouth, lateral sides of mouth, floor of mouth, tongue, or eye. The amount of time required to remove the hook was recorded as short ($<$10 s) or long ($>$10 s). Once the hook was removed, bleeding was noted as none, slight, or moderate, and the total length (TL; mm) of the fish was measured. The depth of the hook ingestion was measured from the anterior tip of the lower jaw to the most posterior point of hook penetration. Because the depth of hook ingestion was recorded relative to the total length of the fish, a comparison of hook ingestion depth was possible across fish of different sizes. The fish were then tagged using individually numbered Floy anchor tags inserted on the left side between the spiny and soft dorsal fins (Tranquilli and Childress 1982).

Once processed, the fish were placed in covered coolers for a maximum of 30 min before being released into a 12-$m^3$ retention cage that was submerged at a minimum depth of 1 m below the surface of the water. The temperature and dissolved oxygen content of the water in the retention cage were measured twice daily at a depth of 1.5 m. Both the coolers and the retention cage had a continuous influx of freshwater from Lake Erie, which reduced the risk of confounding morbidity and mortality estimates due to the effects of stagnant water and degrading water quality on the fish. The fish were held for 72 h in the holding pens, and fish mortality was noted at 24, 48, and 72 h

TABLE 1.—The number of smallmouth bass caught per sampling date by anglers of two experience levels (experienced [E], fished >100 d/year; novice [N], fished <10 d/year) using barbed, single-hook jigs similarly threaded with scented (power, anise, or salt) and unscented lures and natural bait (minnows).

| | Day 1 | | Day 2 | | Day 3 | | |
|---|---|---|---|---|---|---|---|
| Bait type | E | N | E | N | E | N | Total |
| Power | 7 | 5 | 10 | 3 | 18 | 7 | 50 |
| Anise | 7 | 4 | 6 | 8 | 23 | 0 | 48 |
| Salt | 8 | 3 | 10 | 5 | 18 | 6 | 50 |
| Unscented | 8 | 4 | 7 | 5 | 23 | 0 | 47 |
| Minnows | 5 | 3 | 3 | 6 | 18 | 8 | 43 |
| All bait types | 35 | 19 | 36 | 27 | 100 | 21 | 238 |

after capture. In addition, all fish were examined for inflamed (red and swollen) hook or tagging wounds just prior to their release into the lake.

The categorical data were analyzed with logistic regressions using the statistical package SAS, version 8.00 (SAS Institute, Inc.). For each categorical (dependent) variable of bleeding, handling time, and anatomical hooking location, the factors included as independent variables in the analysis were the effect of sampling date, experience of the angler, and type of terminal gear used. The logistic regression analyses were restricted to main-effects comparisons due to the relatively low number of data points when the combined effects of all factors in the analysis were included. Although this may be a limitation, the main-effects comparisons were the primary focus in this study. Finally, a comparison of the most posterior point of hook penetration among fish of different lengths was made possible by using the relative depth (ingestion depth of hook relative to length of fish). These continuous depth-of-hook-penetration data were analyzed using three factors (date of capture, experience of angler, and type of bait) in a three-way analysis of variance (ANOVA).

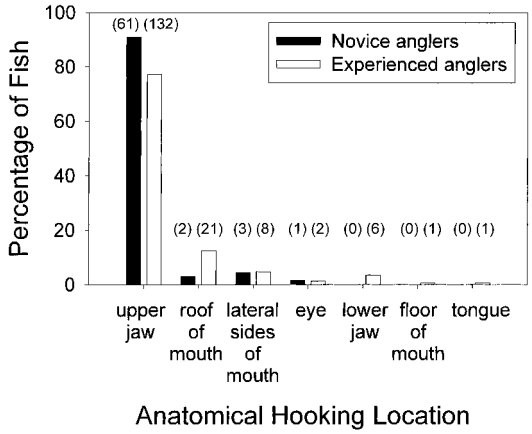


FIGURE 1.—A frequency distribution of the anatomical hooking location for all fish captured by both novice (fished < 10 d/year) and experienced (fished > 100 d/year) anglers. The majority of fish captured by novice and experienced anglers (91.0% and 77.2%, respectively) were hooked in the upper jaw. Sample sizes are given in parentheses above the bars.

## Results and Discussion

Altogether, 238 adult smallmouth bass (mean TL [±SE] = 309.37 ± 29.56 mm) were captured on 3 separate days by anglers of both experience levels (Table 1). Although fish were hooked in all seven anatomical hooking locations, for analysis, hooking locations were grouped into two categories (upper jaw and other) due to the sparsity of data points in all locations other than upper jaw (Figure 1). None of these fish died immediately (within 1 h) due to the injuries incurred from angling, and no short-term mortality (within 72 h) occurred while the fish were held in the retention cages. Upon inspection of each fish before their release, neither the tagging location nor the hook wound appeared to be inflamed. Additionally, no disease or injury resulting from the angling or handling procedure was apparent.

The lack of fish mortality (0%) and disease observed throughout the study could be due to relatively low average water temperatures on angling (15.0°C ± 1.4°C) and retention (15.9°C ± 2.4°C) days, combined with the relatively high dissolved oxygen content of the water (>10 mg/L). Muoneke (1992) suggests that higher water temperatures can increase the risk of hooking mortality in bluegills *Lepomis macrochirus*, potentially due to the increased vulnerability to disease or infection in warmer water. A similar positive correlation between water temperature and mortality has been found in rainbow trout, which were exercised to exhaustion (Dotson 1982), and in cutthroat trout (Titus and Vanicek 1988). During the present study, the maximum water temperature rose to

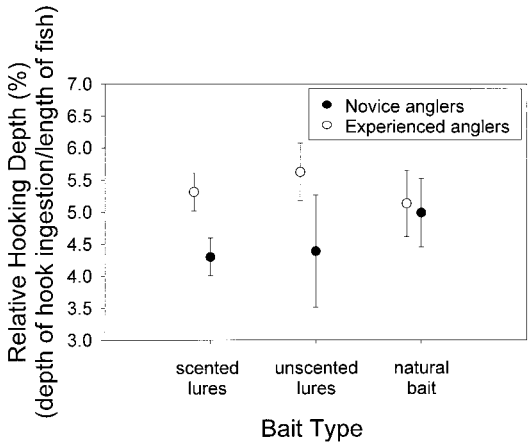


FIGURE 2.—A comparison of the relative depth of hook penetration across scented lures (power, anise, and salt), unscented lures, or natural bait (minnows) for both novice (fished < 10 d/year) and experienced (fished > 100 d/year) anglers. Each value is the average expressed for the group, and the bars represent the standard errors of the measurements.

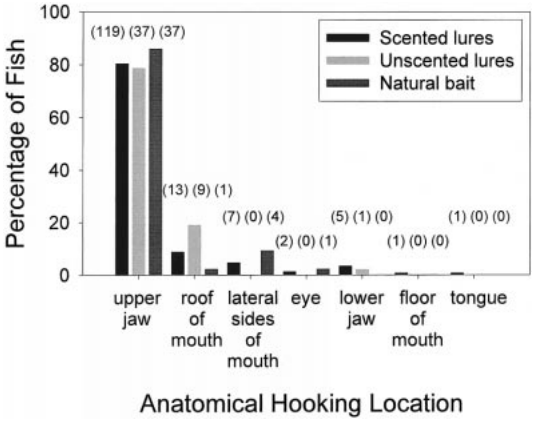


FIGURE 3.—A frequency distribution of the anatomical hooking location of smallmouth bass captured by both novice (fished < 10 d/year) and experienced (fished > 100 d/year) anglers using scented lures (power, anise, and salt), unscented lures, or natural bait (minnows). Sample sizes are given in parentheses above the bars.

22.0°C but only remained at that level for a short time (several hours). In addition, the angling duration (time from initial hooking to landing) was relatively short. Perhaps a prolonged increase in temperature or a longer angling duration would have produced deleterious effects that could lead to mortality in captured smallmouth bass.

Hooking location is generally associated with mortality in captured fish; fish hooked in a vital anatomical area suffer a higher risk of death (Pauley and Thomas 1993; Vincent-Lang et al. 1993; Schisler and Bergersen 1996). Compared with artificial lures, the use of natural bait has resulted in deeper hook ingestion in walleyes (Payer et al. 1989), smallmouth bass (Clapp and Clark 1989), and bluegills (Siewert and Cave 1990). In those studies, however, the natural baits were fished passively (drifting), whereas the artificial baits were actively (trolling or casting) fished. Schisler and Bergersen (1996) determined that the method of fishing affects the frequency of critically injured fish; rainbow trout caught on artificial baits fished passively were more likely to be hooked in critical areas than those caught on artificial baits fished actively. Therefore, differences in fishing methods between artificial lures and natural baits could account for the difference in hooking mortality between natural baits and artificial lures. Other research has found no differences in the hooking depth among passively and actively angled walleyes captured on natural and artificial baits (Schaefer 1989). The current study, which entailed active angling for smallmouth bass with both natural baits and artificial lures, found hooking depth was not dependent on the type of bait used (ANOVA; df = 1, $P = 0.5183$; Figure 2).

However, across the types of artificial baits used in this study, it was found that fish captured with salted baits were hooked significantly more frequently in upper jaw than other anatomical hooking locations compared with fish captured with anise-scented artificial lures ($\chi^2$ test; df = 1, $P = 0.0077$). However, even within anise-scented lures, the frequency of hooking in the upper jaw remained higher (75% of total fish captured on anise bait) than all other potential hooking locations. Further, when all bait types were combined, the majority of the fish captured were hooked in the upper jaw, which therefore indicated that bait type has little effect on the anatomical hooking location of fish captured on single-hook jigs (Figure 3).

As with the relationship between hooking location and mortality, previous studies have found that the amount of bleeding at the hook wound generally increases with more posterior points of hook penetration in captured cutthroat trout (Pauley and Thomas 1993), rainbow trout (Schisler and Bergersen 1996), and coho salmon *Oncorhynchus kisutch* (Vincent-Lang et al. 1993). This effect is due to the greater amount of vital tissue deep in the throat (Schaefer 1989) and the increasing difficulty of hook removal with depth of hook ingestion. Previous research determined that the re-

TABLE 2.—The number of smallmouth bass that experienced bleeding at the hook wound when caught by novice (N, fished <10 d/year) and expert (E, fished >100 d/year) anglers using barbed, single-hook jigs similarly threaded with scented (power, anise, or salt) and unscented lures and natural bait (minnows).

| | Amount of bleeding | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | None | | Slight | | Moderate | | Total caught | | % bleeding[a] | |
| Bait type | E | N | E | N | E | N | E | N | E | N |
| Power | 30 | 11 | 5 | 2 | 0 | 2 | 35 | 15 | 14.3 | 26.7 |
| Anise | 30 | 11 | 5 | 1 | 1 | 0 | 36 | 12 | 16.7 | 8.3 |
| Salt | 32 | 12 | 4 | 2 | 0 | 0 | 36 | 14 | 11.1 | 14.3 |
| Unscented | 32 | 7 | 5 | 2 | 1 | 0 | 38 | 9 | 13.2 | 22.2 |
| Minnows | 22 | 14 | 3 | 3 | 1 | 0 | 26 | 17 | 15.3 | 17.6 |
| All bait types | 146 | 55 | 22 | 10 | 3 | 2 | 171 | 57 | 14.6 | 21.0 |

[a] Total number of fish experiencing any bleeding when caught on a given bait type by anglers of one experience level divided by the total number of fish caught on that bait type by anglers of that experience level.

moval of deeply ingested hooks resulted in a higher risk of mortality in Atlantic salmon *Salmo salar* (Warner 1979), rainbow trout (Mason and Hunt 1967), and smallmouth bass (Weidlein 1989). In our study, 84.4% of captured fish experienced no bleeding at the hook wound, 13.4% bled slightly, and 2.1% experienced moderate bleeding (Table 2). This low incidence of bleeding among captured fish is related to the fact that 81.1% of captured fish were hooked in the upper jaw (and not in vital tissue deep in the throat) by both experienced and novice anglers (Figure 1) and across all types of bait (Figure 3). Similarly, this high frequency of hooking in the upper jaw may also explain why the presence of bleeding was not significantly related to bait type ($\chi^2$ test; df = 1, $P > 0.6741$) for all bait types; Table 2) or experience level of the angler ($\chi^2$ test; df = 1, $P = 0.6743$).

Although never previously tested to our knowledge, the experience level of the angler affected both the depth and anatomical hooking location of the captured fish. That is, experienced anglers hooked fish significantly deeper in the mouth than did novice anglers (ANOVA; df = 1, $P = 0.0096$; Figure 2). It then follows that experienced anglers also hooked the fish significantly more in locations other than the upper jaw than did novice anglers ($\chi^2$ test; df = 1, $P = 0.0194$, Figure 1) and therefore increased the risk of damaging vital tissue. This effect of angler experience level on the hooking depth could be due to differing angling techniques across the range of angling expertise in our study.

Angler experience level did not significantly affect the handling time of captured fish in this study; however, this is in part due to the high frequency of hooking the fish in the premaxillary region by the novice anglers. This does not support a previous study in which novice anglers induced more stress on captured tiger muskellunge (northern pike *Esox lucius* × muskellunge *E. masquinongy*) by hesitating to remove the hook expeditiously, which subjected the fish to longer air exposure (Newman and Storck 1986). Although the dental morphology of centrarchids differs from that of muskellunge, truly novice anglers, such as the ones in the present study, would not have the experience to realize this and therefore may hesitate to remove a hook from any type of fish. However, because the present study used single-hook, barbed jigs, any differences between novice and experienced anglers regarding handling time and the resultant stress response may not have been detected because of the relative ease of hook removal with this lure configuration.

The hooking mortality of captured fish can be affected by the amount of stress to which the fish is exposed throughout the catch-and-release procedure. Prolonged stress resulting from excessive handling or crowding can cause captured fish to be more prone to disease (Wedemeyer 1970; Muoneke and Childress 1994), and the survival of captured fish may also be affected by their exposure to air (Ferguson and Tufts 1992). As the present study attempted to minimize air exposure of captured fish to reduce their potential hooking mortality, the majority of fish (88.2%) captured came off the hook easily (<10 s) and were processed (measured and tagged) quickly (<30 s). Therefore it is reasonable to assume that this brief air exposure did not adversely affect the survival of captured fish.

In conclusion, the results of this study demonstrate that regulations governing the use of chem-

ical attractants appear unnecessary if their initial implementation was due to a greater possible risk of mortality in the target fish species. The imposition of such regulations as this can lead to poor acceptance of and compliance with these and other regulations (American Fisheries Society 1995). The present study consistently found a zero rate of hooking mortality and a low incidence of injury among smallmouth bass angled with natural baits, unscented lures, and lures scented with several types of chemical attractant. Although these results are constrained by the short sampling time and limited temperature range, they are representative of a set of conditions experienced in many centrarchid recreational fisheries. Similarly, although the use of a single lure configuration limits the application of these results, the single-hook lead jig is popular among bass anglers. If other angling conditions and lure configurations provide similar results, it may be necessary to reevaluate the imposition of such regulations indiscriminately across fish species and apply it more selectively as warranted.

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