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Short communication

The effectiveness of bite-shortened hooks for reducing handling time and injury of small-bodied freshwater fish captured by recreational anglers

Tara M. Lepine [a], William M. Twardek [a], Brooke Etherington [a], Mike Dusevic [a], Luc LaRochelle [a], Andy J. Danylchuk [b], Steven J. Cooke [a,*]

[a] *Fish Ecology and Conservation Physiology Laboratory, Department of Biology and Institute of Environmental and Interdisciplinary Science, Carleton University, 1125 Colonel By Drive, Ottawa, ON K1S 5B6, Canada*

[b] *Department of Environmental Conservation, University of Massachusetts Amherst, 160 Holdsworth Way, Amherst, MA 01003, USA*

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ABSTRACT

Modified bite-shortened hooks show promise for enabling easy handling and rapid release of fish captured by recreational anglers, with the potential to reduce injury and stress of released fish. This study investigated whether bite-shortened modified hooks were effective at improving fish welfare relative to more traditional hook configurations. We evaluated how hook type (jigs vs. Aberdeen), hook length (regular, shortened by 4 mm or shortened by 6 mm), and the presence or absence of a barb influenced the landing rates, handling time, hooking depth, ease of hook removal, and injury of Bluegill (*Lepomis macrochirus*). There was significantly more fish landed using jig style (87.7%) than Aberdeen hooks (80.5%). The landing rates varied significantly among hook configurations with standard barbed hooks having the highest landing success (96%) and very bite-shortened hooks having the lowest (67%) landing success. Once landed, self-release (i.e., unhooked without use of hands) was most common for fish caught on very bite-shortened (shortened by 6 mm), followed by short bite-shortened (shortened by 4 mm), and then regular barbless hooks (hook not modified), while regular barbed hooks had the lowest self-release rate. Very short bite-shortened and short bite-shortened barbless hook configurations resulted in shallower hook depths and were less likely to cause injury compared to barbed and barbless regular length hooks. This research suggests that bite shortened barbless hooks allow for easy and rapid self-release while retaining reasonably high rates of landing success, suggesting that bite-shortened hooks could be a useful management tool for recreational fisheries.

1. Introduction

Catch-and-release (C&R) is a commonly used management strategy to reduce the harvest rates of fish captured in recreational fisheries (Cooke and Schramm, 2007). For C&R to be an effective conservation tool, fish being released must survive the angling interaction with negligible impacts to their fitness (Bartholomew and Bohnsack, 2005). However, captured fish can be injured by hooking, exercised to exhaustion, handled, and lifted out of the water, increasing the stress associated with capture and likelihood of mortality (reviewed in Brownscombe et al., 2017). Injury from hooking is likely the leading source of mortality in fish that are captured and released, and that these rates can vary greatly on the severity of the injury (reviewed in Bartholomew and Bohnsack, 2005; Hühn and Arlinghaus, 2011). Research to understand and mitigate the causes of hooking injuries and mortality can improve fish welfare and the sustainability of recreational fisheries (Cooke and Suski, 2005).

When properly setting the hook on a fish, it is inevitable that damage occurs because of the hooking event, regardless of the hook type, puncturing the mouth tissue (Brownscombe et al., 2017). The location and damage associated with hooking can vary by hook (e.g., type, size), fish (e.g., size, sex, species), and environmental (e.g., temperature, habitat) characteristics (Cooke and Sneddon, 2007; Brownscombe et al., 2017). Much of the stress and damage associated with hooking occurs during the unhooking process (Brownscombe et al., 2017), highlighting the important link between hook type and handling. Handling time increases when anglers use barbed hooks and treble hooks (reviewed in Bartholomew and Bohnsack, 2005). Modifications to conventional hook designs can reduce injury and handling times (Shaeffer and Hoffman, 2002; Cooke and Suski, 2004). Some of these modifications include circle hooks to reduce mortality and deep gut hooking (Cooke and Suski, 2004) and suggested effective hook size to be small enough to fit in the

* Corresponding author.

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mouth of the fish and large enough to allow for jaw hooking (Cooke et al., 2005; Alós et al., 2008a, 2008b; Garner et al., 2020). For example, bite-shortened hooks can reduce handling and air exposure by allowing fish the opportunity to self-release (Harris et al., 2021). However, it is unclear how these hooks will perform across species or with other hook configurations.

The purpose of this study was to test the potential effectiveness of using bite-shortened hooks could successfully land Bluegill (*Lepomis macrochirus*) and test if they also reduce handling time. Bluegills were chosen because of their abundance and the ease of being able to catch them. Two different hook types (i.e., bare hook Aberdeen vs jig head) with four varying hook configurations (i.e., regular length barbed, regular length barbless, bite-shortened barbless, and very bite-shortened barbless) were tested to assess whether bite-shortened hooks reduce injury and handling time during C&R angling. Landing success was quantified for each hook configuration to evaluate whether there were trade-offs between catch success and individual fish welfare.

2. Methods

2.1. Study site and fish capture

Bluegill angling was performed in the littoral zone of Big Rideau Lake, ON (44.7706° N, 76.2152° W). For this experiment, angling took place during daytime hours from July 22 to August 5, 2021. Water temperatures were approximately 24 °C during the study period. Data was collected for each of the eight hook types in 30-minute intervals, alternating the order they were used during each day of the trials (as per Harris et al., 2021). This experiment was conducted by three anglers, each with intermediate fishing experience. Each angler used a medium-light action rod setup with monofilament line (2.7 kg). All fish were caught under a scientific collection permit from the Ontario Ministry of Natural Resources and Forestry (permit #FMZ Cooke 2021) and an Animal Care Certificate from Carleton University (protocol #Cooke C&R Umbrella).

2.2. Hook configurations

There was a total of eight hook types/configurations tested in this experiment, with one hundred fish caught per configuration (Fig. 1). Fish were caught on either a "Red Wolf" Aberdeen hook (size 6) or a "Red Wolf" round barbed jigs (1.8 g), which were configured into either regular length barbed, regular length barbless, short bite-shortened barbless, or very short bite-shortened barbless hooks (Fig. 1). The Aberdeen hook setups were accompanied by two 735-B round split shot weights (each 0.31 g). All hook types were baited using one Berkley "Gulp! Alive! ®" white maggot. Apart from the standard barbed hooks, the remaining hooks used in the study were modified. The barbless hook started as the standard and was grinded to remove and flatten the barb using a Worksharp knife and tool sharpener. Hooks were shortened by cutting (side cutter pliers) from the hook point to immediately below the barb, followed by sharpening and smoothing of the point using a medium coarse grit belt at 220-grit. This corresponded to removing 4 mm of hook for the short and 6 mm of hook very short bite-shortened hooks. Prior to use, hooks were assessed for quality and consistency.

2.3. Data collection

Landing success was documented by recording every confirmed Bluegill lost as well as unidentified fish losses that should have been landed onto the boat. The fish were landed onto the boat by flipping them onto the boat, without the use of net or hands. A fish was deemed lost if the hook was set and the fish attempted to escape the angling gear (i.e., fought) but was not brought into the boat. Upon landing, hooked fish were immediately placed into a 7.5 L bucket of fresh lake water on the boat. Fish were then given ten seconds in the 7.5 L to self-release, followed by an additional ten seconds to release with assistance by agitating the line, and finally timing the additional handling time required to successfully unhook the fish. Time was recorded on a stopwatch for all trials. All fish were unhooked by the same angler to ensure replicability across trials. The total time needed for release included fish that self-released, those who required assistance, and those who were handled for removal. Any fish that unhooked itself prior to being placed

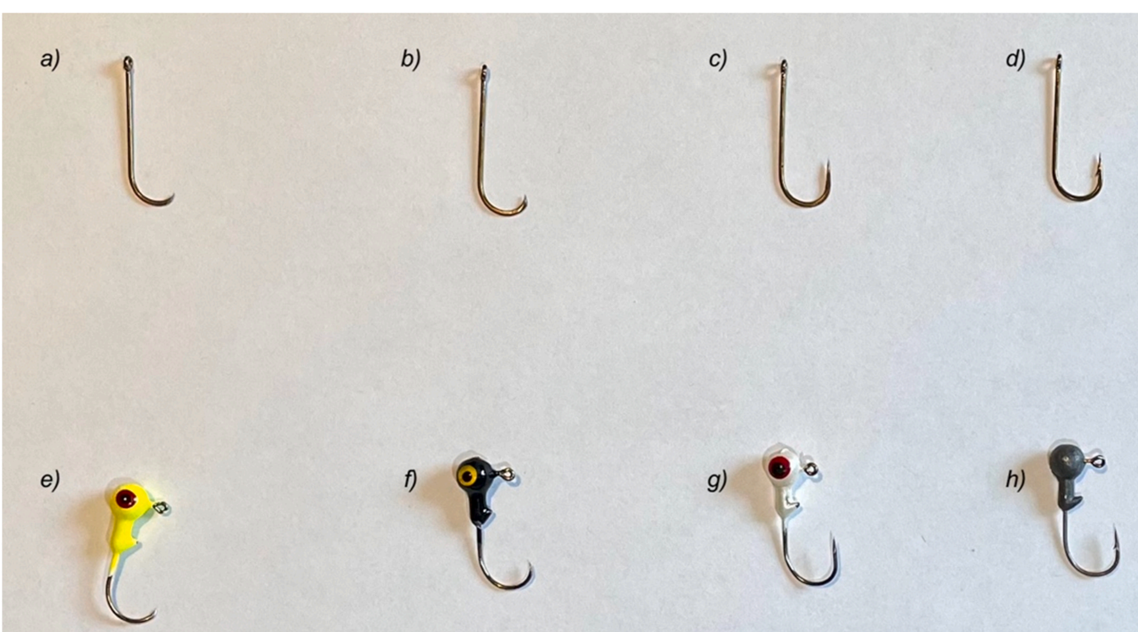

Fig. 1. Hook types and configurations used to evaluate effectiveness of bite-shortened hooks for landing success and reducing handling time in catch-and-release of Bluegill. (A) very short Aberdeen hook cut and sharpened 6 mm from original hook point, (B) short Aberdeen hook cut and sharpened 4 mm from original hook point, (C) regular length barbless Aberdeen hook, (D) regular length barbed Aberdeen hook, (E) very-short jig hook, cut and sharpened 6 mm from original hook point, (F) short jig hook, cut and sharpened 4 mm from original hook point, (G) regular length barbless jig hook, (H) regular length barbed jig hook.

in the bucket but made it into the boat, was considered to have self-released at 0 s. This experiment excluded non-target species (e.g., Pumpkinseed, Yellow Perch), as well as any deep-hooked Bluegill where removing the hook could have led to mortality of the fish (Cooke and Danylchuk, 2020). All fish hooked in the gullet or requiring tools for hook removal were considered "deep-hooked". Once unhooked, the total length, hook location (classified as: lower jaw; upper jaw; eye; gills; or could not be identified), hooking depth (measured in mm from snout to hook location), and presence or absence of injuries or blood were recorded for each fish (Cooke et al., 2021). Only injuries and signs of bleeding that would have been directly caused by being hooked and handled were recorded (Meka, 2004).

2.4. Statistical analyses

Statistical models were developed for the response variables of release outcome (i.e., unhooked with or without assistance), hook depth (i.e., location of hook in the mouth), presence of blood, and injury (i.e., tearing, damage). For each model, hook type (Aberdeen vs. jigs), hook configuration (barbed regular length, barbless regular length, barbless short bite-shortened, or barbless very short bite-shortened), and fish length (mm) were used as predictor variables. Reference parameters within the logistic regression model were "Aberdeen" for hook type and "barbed" for hook configuration. Candidate models first included the interaction between hook type and configuration, but this interaction was not significant and was excluded from final models. The release outcome (i.e., how the hook was removed) was converted to a binomial response with three variables; self-released within 10 s, self-release after 20 s with line agitation or unhooked with assistance after 10 s, and was modeled using a logistic regression. A gamma regression (specifying a log link) was then conducted for total unhooking durations for fish that required assistance (i.e., >10 s). The presence of blood and injury were also modeled using separate logistic regressions. A linear regression was used to model hook depth (expressed as a percent of body length). Hook depth was right skewed and was transformed using a log+ 1 transformation. Post-hoc tests were conducted on significant predictor variables using the *glht* function (multcomp package) specifying "Tukey". Logistic regression was used to model landing success rates To evaluate whether hook characteristics influenced the size of fish captured, a multiple regression was conducted with fish length as a dependent variable and hook type and configuration as predictor variables. All statistical analyses were conducted in R statistical software (R Core Team 2021) using packages dplyr, tidyr, ggplot2, and ggpubr. Statistical significance was assessed at an alpha threshold of 0.05. Where applicable, values are presented as mean ± standard error.

3. Results

The mean total length of all fish caught was 161 ± 3 mm. Unhooking durations ranged from 0 to 51 s and varied across hook types and configurations (Fig. 2). Aberdeen and unmodified larger hooks tended to have longer unhooking durations than jigs or the modified shorter hooks. There was no significant difference in the proportion of fish self-released after capture by jigs or Aberdeen hook types (Table 1; Fig. 3A). The proportion of self-released fish was highest for very short bite-shortened hooks (0.89 ± 0.02), short bite-shortened hooks (0.63 ± 0.03), and regular barbless hooks (0.32 ± 0.03), followed by regular barbed hooks (0.11 ± 0.02), regardless of hook type. A post-hoc Tukey test indicated that each of these hook configurations were significantly different from one another (Table 1; Fig. 3; all $p < 0.001$). Fish length was also a statistically significant predictor of the probability of self-release from hooks (Table 1), though the effect size was very small (−0.008 mm). For fish that required assistance during unhooking, those caught on jig hooks had significantly shorter unhooking duration compared to Aberdeen hooks (Table 1). Further, regular barbed hooks resulted in significantly longer unhooking durations amongst fish requiring angler assistance compared to fish caught on regular barbless, short bite-shortened barbless, and very short bite-shortened barbless hooks.

Hook depth did not differ significantly between jigs and Aberdeen hooks, though very short bite-shortened (3.75 ± 0.18%) and short bite-shortened (4.43 ± 0.23%) barbless hooks had significantly shallower hook depths than barbless (5.17 ± 0.24%) and barbed (5.63 ± 0.22%) regular length hooks. Larger fish had significantly shallower hook

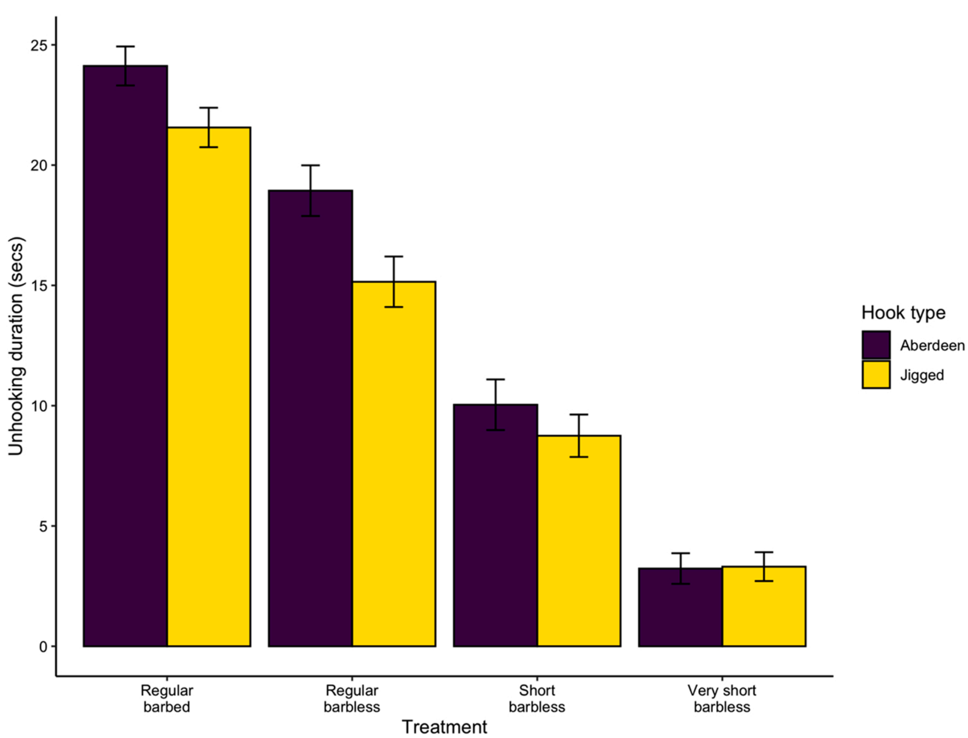

Fig. 2. Mean (± SE) unhooking durations for fish captured across various hook types (Aberdeen or jig) and treatments (barbed vs. barbless and varying lengths).

Table 1
Statistical outputs of models evaluating the relationship between hook type, hook configuration (barbless, short bite-shortened, very short bite-shortened hooks), and fish length (mm), with release outcome, hook depth, presence of injury, presence of bleeding, and landing success. Inferences for factors are presented relative to reference levels ("Aberdeen" for hook type and "regular length and barbed" for configuration. Significant effects are highlighted by bold font.

Response	Model	Predictors	Estimate	SE	t/z value	N	P
Release outcome	GLM (binomial)	Hook type: Jigs	-0.332	0.180	-1.840	799	0.066
		Hook configuration: Regular, barbless	-1.455	0.279	-5.215	399	**< 0.001**
		Hook configuration: Short bite-shortened, barbless	-2.734	0.277	-9.886	399	**< 0.001**
		Hook configuration: Very short bite-shortened, barbless	-4.319	0.328	-13.155	399	**< 0.001**
		Fish length	0.008	0.004	2.357	799	**0.018**
Unhooking duration (assisted release)	Gamma regression (log link)	Hook type: Jigs	-0.0934076	0.023	-4.089	410	**< 0.001**
		Hook configuration: Regular, barbless	-0.071	0.026	-2.711	314	**0.007**
		Hook configuration: Short bite-shortened, barbless	-0.211	0.031	-6.951	252	**< 0.001**
		Hook configuration: Very short bite-shortened, barbless	-0.314	0.052	-6.692	200	**< 0.001**
		Fish length	0.001	0.001	2.151	410	**0.03**
Hook depth	Multiple regression	Hook type: Jigs			0.654	768	0.513
		Hook configuration: Regular, barbless			-1.676	396	0.094
		Hook configuration: Short bite-shortened, barbless			-4.551	392	**< 0.001**
		Hook configuration: Very short bite-shortened, barbless			-6.453	382	**< 0.001**
		Fish length			-2.65	768	**0.008**
Presence of injury	GLM (binomial)	Hook type: Jigs	0.222	0.157	1.416	799	0.157
		Hook configuration: Regular, barbless	-0.421	0.203	-2.072	399	**0.038**
		Hook configuration: Short bite-shortened, barbless	-1.306	0.221	5.917	399	**< 0.001**
		Hook configuration: Very short bite-shortened, barbless	-1.423	0.225	-6.323	399	**< 0.001**
		Fish length	-0.005	0.003	-1.618	799	0.106
Presence of bleeding	GLM (binomial)	Hook type: Jigs	0.435	0.233	1.869	799	0.062
		Hook configuration: Regular, barbless	-0.173	0.308	-0.560	399	0.5754
		Hook configuration: Short bite-shortened, barbless	-0.161	0.307	-0.525	399	0.600
		Hook configuration: Very short bite-shortened, barbless	-0.563	0.336	-1.673	399	0.094
		Fish length	0.004	0.004	0.888	799	0.375
Landing success	GLM (binomial)	Hook type: Jigs	2.994	0.369	2.582	456	**0.010**
		Hook configuration: Regular, barbless	0.369	0.192	-1.389	215	0.165
		Hook configuration: Short bite-shortened, barbless	-0.625	0.450	-3.204	230	**0.001**
		Hook configuration: Very short bite-shortened, barbless	-1.316	0.411	-6.576	300	**< 0.001**

depths relative to their size. The presence of injury did not differ significantly between Aberdeen and jighead hooks, though very short bite-shortened (0.21 ± 0.03) and short bite-shortened (0.23 ± 0.03) barbless hooks were significantly less likely to result in injury than barbless (0.42 ± 0.04) and barbed (0.53 ± 0.04) regular length hooks (Table 1). Overall, bleeding after capture was infrequent (11% of all fish), and the presence of blood did not differ significantly across hook types, hook configurations, or by the length of fish (Table 1).

Almost all (86%) fish that were hooked, were landed. Fish lost tended to be Bluegill (91%) though for some fish lost, the species could not be identified (9%). Jigs (87.7%) landed significantly more fish than Aberdeen hooks (80.5%; $\chi^2 = 8.71$, $p = 0.003$). Landing success also differed significantly across the various hook configurations ($\chi^2 = 104.16$, $p < 0.001$). Regular length barbed hooks (96%) had the highest landing success, followed by regular length barbless (93%), short bite-shortened barbless (87%), and very short bite-shortened barbless hooks (67%). Each of these landing success rates were significantly different from one another, aside from the regular length barbed and barbless hook rates (adjusted $p = 0.20$). Fish caught on jigs (164 ± 26 mm) were significantly larger than those caught on Aberdeen hooks (157 ± 26 mm; $p < 0.001$). There was also a significant difference in the size of fish captured on regular length barbless (164 ± 26 mm) compared to barbed hooks (157 ± 26 mm; $p = 0.007$), but hook length did not appear to influence the size of fish caught (Table 1).

4. Discussion

4.1. Hooking outcomes

Reducing handling time while unhooking fish has the capability to improve fish welfare in recreational fisheries by reducing stress levels associated with extended handling periods and air exposure durations. We found that the use of barbless, bite-shortened hooks (Fig. 2) has the potential to reduce fish handling time and injury, while maintaining efficient landing rates. Bite-shortened hooks allow for the highest proportion of self-released (i.e., released without the aid of a hand) fish compared to regular length hooks (Fig. 2A). Further, very short bite-shortened and short bite-shortened barbless hook configurations resulted in shallow hooking depths (Fig. 2B) which lowers the risk of deep hooking and injury (Fig. 2C; Cooke et al., 2001). Indeed, these shallower hooking depths likely resulted in the higher rates of self-release relative to unmodified hook types. Our findings are consistent with those on Spotted Seatrout (*Cynoscion nebulosus*) that suggest bite-shortened hooks improve C&R outcomes (Harris et al., 2021). The improved outcomes include minimizing direct handling of fish and hooking injury. Although few studies have evaluated the effectiveness of bite-shortened hooks, many studies have investigated the influence of hook size on hooking outcomes. These studies have shown that larger hooks tend to reduce the rate of deep-hooking and can lead to reduced injuries for shallow-hooked fish (Alós et al., 2008a,2008b; Salierno et al., 2018).

In addition to shortened-hooks, barbless regular length hooks also increased the likelihood of self-release and tended to improve catch outcomes relative to the regular length barbed hook. These findings are consistent with literature that has shown barbless hooks tend to decrease

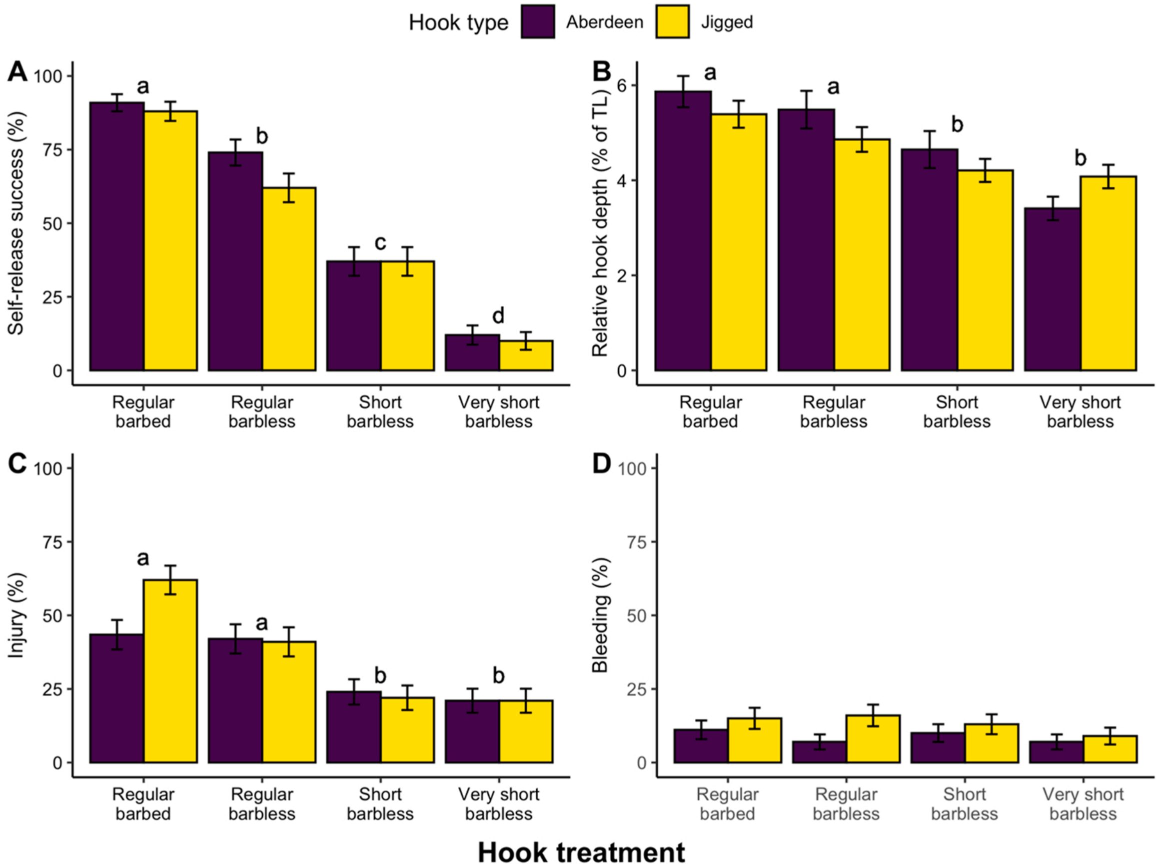

Fig. 3. Mean (± SE) proportion of (A) self-release success, (B) hook depth in relation to total length, (C) injury, and (D) bleeding of Bluegill across different hook types and configurations. Different letters denote statistically significant differences (P < 0.001) between configuration groups in each panel.

handling time and reduce injury (Cooke et al., 2001; Shaeffer and Hoffman, 2002; Meka, 2004; Stein et al., 2012). Indeed, barbs have the inherent purpose of making it more difficult for a fish to detach from an embedded hook, which explains why it can also be more difficult to remove barbed hooks. While we failed to observe many differences in handling and hooking outcomes for fish captured on Aberdeen hooks and jig hooks, it could be hypothesized that the larger size of a jig could decrease the likelihood of the hooks being swallowed. Indeed, previous research found that jigs reduced deep hooking in both captured walleye (*Sander vitreus*) and rock bass (*Ambloplites rupestris*) relative to regular hooks, though mortality rates were similar (Cooke et al., 2001; Reeves and Bruesewitz, 2007; Reeves and Staples, 2011). Bite-shortened hooks allowing for fish to self-release can reduce stress and injury by eliminating the need for air exposure or handling and could work well with hook removal gears (Cooke et al., 2022).

4.2. Landing rates

Overall, bite-shortened hooks tended to have lower landing rates compared to regular length hooks which may compromise angler satisfaction (Birdsong et al., 2021) and broad implementation and adoption in recreational fisheries. While very short bite-shortened hooks had the highest proportion of self-released fish and the lowest landing rate (67%), short bite-shortened hooks were effective at self-releasing yet had a much higher landing success rate (87%). As such, the short bite-shortened hook configuration likely presents the most reasonable solution for both fish conservation and angler satisfaction. Although lower landing success rates may negatively impact the ability to convince anglers to adopt bite-shortened hooks, using fish welfare as a method to push this incentive might help with hook regulations that may help with the conservation of fisheries (discussed in Cooke et al., 2012). However, in fisheries that are only C&R the bite-shortened hooks might be of interest, especially in fisheries that already have barbless regulations and fish are often deeply hooked. The landing success of bite-shortened hooks in this study were found to be less than those found in the study by Harris et al. (2021). It is possible that results between the two studies differ because large fish can be deeply hooked which reduces the ability to be self-released (harder to expel hooks) which can increase the landing success (Harris et al., 2021). Angler proficiency also has an important role on the landing success as experienced anglers can keep tension on the line in a timely manner which is important for landing success, especially with bite-shortened hooks (Harris et al., 2021). It is possible that angler skill level would influence the outcome of this study where anglers with more experience and knowledge would have greater landing success, compared to novice annglers that would have reduced landing success.

4.3. Conclusion

Bite-shortened hooks, cut 4 mm from the point of the hook, were able to significantly reduce handling time and injury in Bluegill while still producing a reasonably high landing success rate. The handling times were evidently reduced through the proportion of fish able to self-release from the hooks without assistance. These results support previous work (i.e., Harris et al., 2021) and encourage further research to assess whether the results are replicable under a variety of contexts (e.g., different bite-shortening lengths, angler proficiencies, and species). Further research is also required to determine the best length for bite-shortened hooks, considering both self-release success rates, and landing rates across different species, body sizes hook size and angler experience. For bite-shortened hooks to be adopted in recreational fisheries, they should be standardized and made more accessible to anglers (rather than having to cut and sharpen hooks as we did here). Our study supports the notion that using bite-shortened hooks in recreational fisheries could improve fish welfare while still allowing anglers to fish with functional hooks.

CRediT authorship contribution statement

T.M Lepine: Conceptualization, Methodology, Investigation, Resources, Data curation, Writing – original draft, Visualization. **W.M. Twardek:** Software, Formal analysis, Writing – review & editing, Visualization. **B. Etherington:** Conceptualization, Investigation, Resources. **M. Dusevic:** Conceptualization, Investigation, Resources. **L. LaRochelle:** Conceptualization, Writing – review & editing. **A.J. Danylchuck:** Writing – review & editing. **S.J. Cooke:** Conceptualization, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors report no declaration of competing interest.

Data Availability

Data will be made available on request.

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References

Alós, J., Cerdà, S., Deudero, S., Grau, A.M., 2008a. Influence of hook size and type on short-term mortality, hooking location and size selectivity in a Spanish recreational fishery. J. Appl. Ichthyol. 24 (6), 658–663.
Alós, J., Palmer, M., Grau, A.M., Deudero, S., 2008b. Effects of hook size and barbless hooks on hooking injury, catch per unit effort, and fish size in a mixed-species recreational fishery in the western Mediterranean Sea. ICES J. Mar. Sci. 65 (6), 899–905.
Bartholomew, A., Bohnsack, J.A., 2005. A review of catch-and-release angling mortality with implications for no-take reserves. Rev. Fish. Biol. Fish. 15 (1–2), 129–154.
Birdsong, M., Hunt, L.M., Arlinghaus, R., 2021. Recreational angler satisfaction: what drives it? Fish Fish. 22 (4), 682–706.
Brownscombe, J.W., Danylchuk, A.J., Chapman, J.M., Gutowsky, L.F.G., Cooke, S.J., 2017. Best practices for catch-and-release recreational fisheries-angling tools and tactics. Fish. Res. 186, 693–705.
Cooke, S.J., Danylchuk, A.J., 2020. Hook disgorgers remove deep hooks but kill fish: a plea for cutting the line. Fish. Manag. Ecol. 27, 622–627.
Cooke, S.J., Schramm, H.L., 2007. Catch-and-release science and its application to conservation and management of recreational fisheries. Fish. Manag. Ecol. 14, 73–79.
Cooke, S.J., Sneddon, L.U., 2007. Animal welfare perspectives on recreational angling. Appl. Anim. Behav. Sci. 104 (3–4), 176–198.
Cooke, S.J., Suski, C.D., 2004. Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? Aquat. Conserv.: Mar. Freshw. Ecosyst. 14, 299–326.
Cooke, S.J., Suski, C.D., 2005. Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources? Biodivers. Conserv. 14 (5), 1195–1209.
Cooke, S.J., Philipp, D.P., Dunmall, K.M., Schreer, J.F., 2001. The influence of terminal tackle on injury, handling time, and cardiac disturbance of rock bass. North Am. J. Fish. Manag. 21 (2), 333–342.
Cooke, S.J., Barthel, B.L., Suski, C.D., Siepker, M.J., Philipp, D.P., 2005. Influence of circle hook size on hooking efficiency, injury, and size selectivity of Bluegill with comments on circle hook conservation benefits in recreational fisheries. North Am. J. Fish. Manag. 25 (1), 211–219.
Cooke, S.J., Nguyen, V.M., Murchie, K.J., Danylchuk, A.J., Suski, C.D., 2012. Scientific and stakeholder perspectives on the use of circle hooks in recreational fisheries. Bull. Mar. Sci. 88 (3), 395–410.
Cooke, S.J., Cooke, C.J.A., Cooke, J.T.H., Cooke, B.W.C., Danylchuk, A.J., Brownscombe, J.W., 2021. Efficacy of dehooking tools for the removal of hooks from the jaw region of angled fish. Fish. Res. 240, 105965.
Cooke, S.J., Cooke, B.W.C., Cooke, J.T.H., Cooke, C.J.A., LaRochelle, L., Danylchuk, A.J., Danylchuk, S.C., Lennox, R.J., 2022. Evaluating different hook removal gear for in-water dehooking of jaw-hooked fish captured with barbed or barbless hooks. Fish. Res. 248, 106201.
Garner, S.B., Patterson III, W.F., Walter, J.F., Porch, C.E., 2020. Simulating effects of hook-size regulations on recreational harvest efficiency in the northern Gulf of Mexico red snapper fishery. Fish. Res. 228, 105561.
Harris, H.E., Whalen, B.K., Gude, A.G., Allen, M.S., 2021. Testing a bite-shortened hook to minimize fish handling in a recreational fishery. Fisheries 46 (7), 321–328.
Hühn, D., Arlinghaus, R., 2011. Determinants of Hooking Mortality in Freshwater, 75. American Fisheries Society Symposium, pp. 141–170.
Meka, J.M., 2004. The influence of hook type, angler experience, and fish size on injury rates and the duration of capture in an Alaskan catch-and-release Rainbow Trout fishery. North Am. J. Fish. Manag. 24 (4), 1309–1321.
Reeves, K.A., Bruesewitz, R.E., 2007. Factors influencing the hooking mortality of walleyes caught by recreational anglers on Mille Lacs, Minnesota. North Am. J. Fish. Manag. 27 (2), 443–452.
Salierno, J.D., Overton, A.S., Benson, C.L., 2018. Optimization of hook size to reduce discards and injury in the New Jersey Summer Flounder Hook-and-Line Fishery. North Am. J. Fish. Manag. 38 (2), 393–399.
Shaeffer, J.S., Hoffman, E.M., 2002. Performance of barbed and barbless hooks in a marine recreational fishery. North Am. J. Fish. Manag. 22, 229–235.
Stein, J.A., Shultz, A.D., Cooke, S.J., Danylchuk, A.J., Hayward, K., Suski, C.D., 2012. The influence of hook size, type and location on hook retention and survival of angled bonefish (*Albula vulpes*). Fish. Res. 113 (1), 147–152.