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ARTICLE

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Hook disgorgers remove deep hooks but kill fish: A plea for cutting the line

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Abstract

Recreational fishing can result in deep hooking (e.g. in the gullet) of fish that are intended to be released, leading to the development of various tools intended to assist with hook removal. So-called "hook disgorgers" are typically marketed as being a mechanism to retrieve the hook while doing so in a way that reduces harm to the fish, despite there being many studies that demonstrate that it is best to cut the line for deeply hooked fish. A study was designed to test the effectiveness of six different hook disgorgers for deeply hooked smallmouth bass, *Micropterus dolomieu* Lacépède, captured using baitholder hooks relative to shallow hooked controls and fish for which the line was cut. Reflex impairment and survival at 10 min, 1 hr and 24 hr were assessed. The study was terminated after early results revealed that all but one of the fish that had the hook removed died ($n = 17$), while all fish that were hooked in the jaw ($n = 4$) or had the line cut ($n = 5$) survived. The ethical conundrum faced by the research team is discussed here, recognising that an incomplete study would have less statistical rigour even though it was very clear that disgorgers used when hooks were in the gullet killed the fish. Stopping rules are common in pharmaceutical trials and can also be used to inform catch-and-release research to maintain fish welfare. Best practices for anglers include cutting the line when fish are hooked in the gullet, and changing fishing strategies and gear type when deep hooking is encountered on a routine basis, otherwise mortality can be unnecessarily high.

KEYWORDS
ethics, fishing hook, hooking mortality, recreational fisheries, stopping rules

1 | CONTEXT

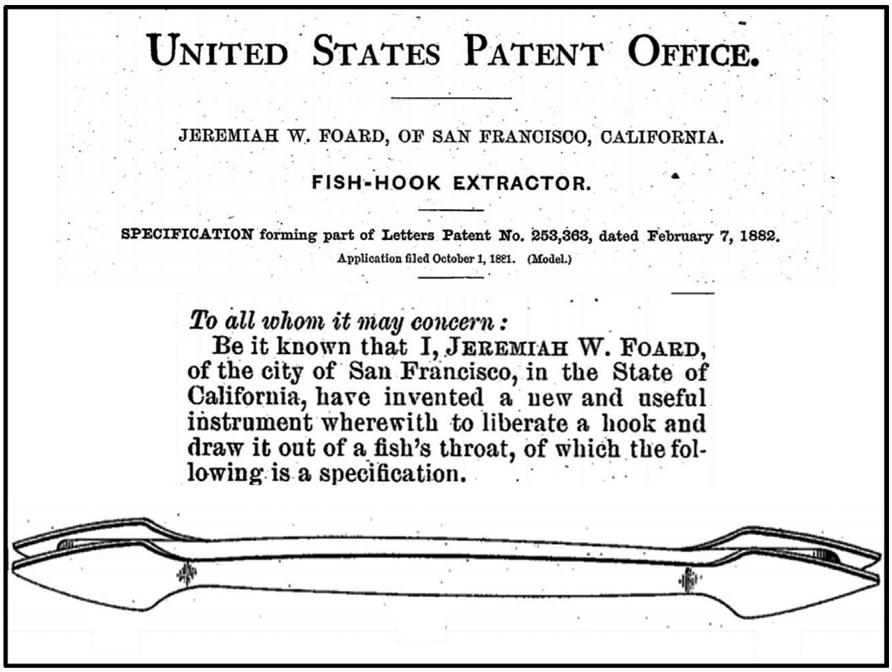
Keeping up with innovations in the recreational fishing sector can be challenging for anglers as they look for tools and techniques to improve their success and the efficiency by which they handle fish, yet it is equally challenging for researchers and regulators who aim to ensure that new gears and methods are not unduly harmful to fish. For instance, as two researchers with a passion for angling and catch-and-release science, there is great interest as more and more options are becoming available for the removal of fish hooks that end up in the gullet of fish. From commercially available products to "how-to" articles (e.g. https://www.wikihow.com/Unhook-a-Fish; https://britishseafishing.co.uk/techniques-and-info/unhooking-and-releasing-fish/) and online videos for fashioning hook disgorgers in your garage, there are now many options available. Yet, there are remarkably few scientific assessments of fish hook disgorgers and their influence on the welfare and survival of fish, including those that are deeply hooked. A search for the words "fish hook remover", "hook disgorger", "fish hook removal device" and "hook extractor" in Google Scholar yields pages and pages of patents for various designs ranging back as early as 1882

(Duncan 2002) (Figure 1). The reasons for developing such devices are varied and range from simply wanting to retrieve the hook so it can be used again (focus on nearly all such tools prior to 1960s based on wording patents, e.g. Kramer, 1929; Underwood, 1948), to efforts intended to benefit fish that are to be released. Today, most tools are marketed in ways that emphasise the apparent dual benefits. Still, not a single scientific article can be found on the effects of these devices on deeply hooked fish.

For fish that are hooked in the mouth in generally benign locations (e.g. peripheral areas such as jaw or roof of mouth), a hook removal device may expediate dislodging the hook from tissue or bone. Indeed, almost all anglers would have a pair of pliers in their tackle box for such purposes. However, most hook disgorgers specifically note that they are designed to remove hooks from the throat of fish (which is interpreted to mean the gullet or oesophagus—the area that connects the mouth to the stomach). The prevalence of "deep hooking" is influenced by a number of factors including bait type (organic baits tend to yield deeper hooking than artificial lures), bait and hook size (smaller baits and hooks tend to yield deeper hooking that larger ones), hook type (conventional J style hooks tend to yield deeper hooking than designs such as circle hooks), fishing style (passive fishing styles such as drifting, bottom fishing and bobber fishing tend to yield deeper hooking than active fishing methods like trolling and casting and retrieving) and angler experience (novice anglers tend to yield deeper hooking than more experienced anglers; reviewed in Brownscombe et al., 2017). Yet, despite this knowledge, deep hooking still occurs.

Deep hooking is regarded as the single biggest driver of mortality outcomes for fish that are caught and released (reviewed in Muoneke & Childress, 1994; Bartholomew & Bohnsack, 2005; Arlinghaus et al., 2007; Cooke et al., 2012; Brownscombe et al. 2017). The gullet, per se, is not a delicate tissue that inherently leads to death if punctured by a hook. However, adjacent to the gullet are vital organs such as the heart and liver along with blood vessels that connect them (e.g. hepatic portal vein). Deeply set hooks thus have the potential to lead to blood loss (which may only be evident internally) and directly damage the ability of the cardiovascular system to sustain life. Extended hook removal times often coincide with prolonged air exposure beyond some species and context-specific threshold which is itself lethal (Cook et al., 2015). For the angler, time spent trying to disgorge a hook is time that could be spent fishing.

Studies exist that investigate whether it is better for anglers to cut the line or attempt to remove deeply set hooks from the gullet. Across the board, these studies reveal that outcomes in terms of short and long-term survival are much superior when deep hooks are left in place and the fish are released. This has been demonstrated in laboratory and mesocosm experiments (e.g. Alos, 2009; Butcher et al., 2007; Fobert et al., 2009; Grixti et al., 2008; Mason & Hunt, 1967; Robert et al., 2011; Schill, 1996; Schisler & Bergersen, 1996; Van der Walt et al., 2005; Warner, 1979), as well as in large-scale field mark–recapture studies (Wilde & Sawynok, 2009). The only exception was a study by DeBoom et al. (2010) where there was no statistical difference in short-term or delayed mortality between different hook removal methods and line cutting (note—this was not a comparison of gears but rather various ways of using pliers). However, sample sizes were low and even the control fish experienced nearly 50% mortality during the study. There can be sublethal consequences with hook retention (e.g. reductions in feeding), but there is evidence for hook shedding in a number of studies (Fobert et al., 2009). Yet, none of these studies compared or contrasted different hook disgorgers.


UNITED STATES PATENT OFFICE.

JEREMIAH W. FOARD, OF SAN FRANCISCO, CALIFORNIA.

FISH-HOOK EXTRACTOR.

SPECIFICATION forming part of Letters Patent No. 253,363, dated February 7, 1882.
Application filed October 1, 1881. (Model.)

To all whom it may concern:
Be it known that I, JEREMIAH W. FOARD, of the city of San Francisco, in the State of California, have invented a new and useful instrument wherewith to liberate a hook and draw it out of a fish's throat, of which the following is a specification.

FIGURE 1 Image of the first fish disgorger which was granted a patent by the United States Patent Office in 1882. This emphasises how the concept of designing and using hook disgorgers is not a new one

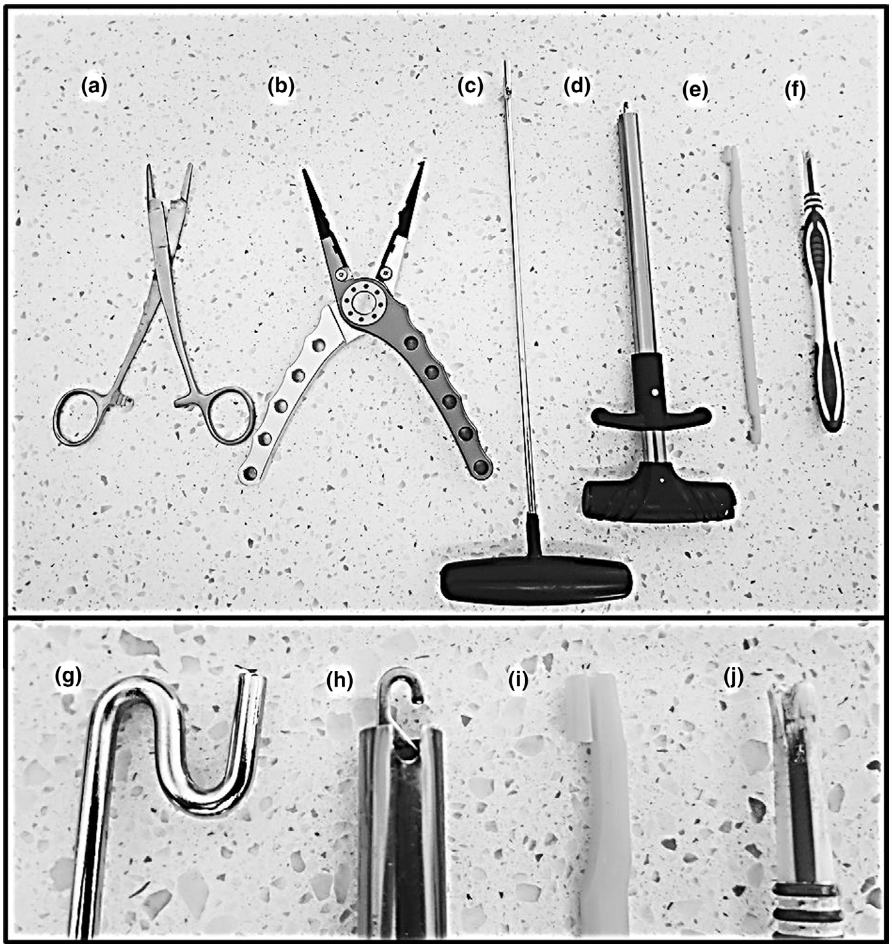


FIGURE 2 Image of contemporary tools used for disgorging hooks. Top panel shows full images of (a) narrow hemostats; (b) pliers; (c) push–pull hook remover; (d) T-handle hook extractor; (e) plastic fishing hook disgorger; and (f) home-made hook disgorger created from toothbrush handle (as per https://www.youtube.com/watch?v=WmsP34UDVz4). The lower panel is a closeup of the end of the (g) push–pull hook remover; (h) T-handle hook extractor; (i) plastic fishing hook disgorger; and (j) home-made hook disgorger

2 | AN INCOMPLETE STUDY

Wearing dual hats as anglers and scientists, the authors have been informally experimenting with different hook removal tools for several years when encountering deeply hooked fish (note—the authors have children and they tend to be chronic deep hookers). Anecdotal observations suggested that these tools did more harm than good for deeply hooked fish. After removing a deep hook and noting the relatively poor condition of the fish, it was common to muse whether it would have been better to cut the line instead. Nonetheless, anecdotes are just that. Therefore, a formal study was designed to test some of the most common hook disgorgers (see Figure 2 for gears tested) and compare them to controls and deeply hooked fish where the line was cut. In this case smallmouth bass, *Micropterus dolomieu* Lacépède, between 180 and 300 mm were caught using a size 6 barbed baitholder hook baited with 10 mm of worm that were cast and left to settle passively in the water until a bite was detected. High rates of deep hooking were achieved by using live bait, hooks that were somewhat small (but very appropriate for the size of fish targeted) and novice angling volunteers (children). Upon capture, fish were assessed for reflex impairment (bursting and righting reflex as per Davis, 2010) and bleeding while temporarily held in a water-filled cooler following treatment after 10 s, at 1 min and at 10 min. Shallow hooked fish (aside from some retained as controls) were released at the site of capture. Survival was assessed at 10 min, 1 hr and 24 hr while holding fish in an 85-L common tank supplied with flow-through ambient lake water (at ~26°C). Although the research occurred over several days and entailed thus several rounds of overnight holding, control fish were used every day to evaluate any tank holding effects over time. The time it took to remove hooks using the different disgorgers was also recorded.

Despite having animal care approvals [CU Protocol 110558] and expectation that mortality would be a possible or even likely outcome, the study was halted after three days and 26 captured fish on ethical grounds. The authors could not justify the damage that was being done to these fish—it was clear that hook disgorgers were not maintaining the welfare status of angled fish. All control fish (n = 4) and line cut fish (n = 5) survived for 24 hr, while all but one of 17 fish in the hook removal treatment group died (the sole survivor had the hook removed with hemostats). Based on the level of tissue damage and bleeding (7 of 17 fish exhibited moderate to severe bleeding), it was clear that these hook disgorgers and attempts to remove the hooks caused significant physical damage to the fish. Some of the disgorgers were also difficult to use and required multiple attempts and nearly one minute (range of 13–58 s) to remove the hook, despite all being conducted by an experienced adult fish handler (SJC). No bleeding was observed for control or line-caught fish. Based on these observations, and when combined with previous literature, cutting the line is the much-preferred approach to dealing with deep hooking. Yet, the dilemma is that if this work was not published (with a mere $n = 3$ for five disgorger treatments and only $n = 2$ for another type) then it represented nothing but anecdotes, and these devices that claimed to be good for the fish would continue to be used. This dilemma was shared on Twitter where it was suggested that the expertise of the two authors on the topic and these preliminary data could be used to share perspectives as an unconventional essay. Hence, the reason for this paper. All of the available evidence to date combined with personal observations (here and otherwise) collectively emphasise that when fish are deeply hooked (i.e. in the gullet), hook removal should never be attempted unless one intends to harvest the fish. But how can the behaviour of the angling community be changed?

3 | BEST PRACTICES FOR DEEPLY HOOKED FISH

Most of the hook removal devices tested here are readily available on Amazon (the world's largest online retailer) for between US$10 and US$20. They can also be found at tackle stores and on other online merchants (like eBay). Online videos show how to make your own fish disgorgers using discarded toothbrushes (like we did here) or wire. If one searches for "fish hook remover" on YouTube numerous videos pop up that have been viewed tens of thousands of times (one as many as 150,000 views) where statements are made such as "… will help you get the hook out of the fish and won't cause any harm to the fish whatsoever…". Most of the device manufacturers or anglers advocating for their use make similar claims. Yet, unlike in scientific catch-and-release studies where fish are retained in tanks, pens or mesocosms (to monitor fish), these fish tend to be immediately released. Post-release mortality is rather cryptic (Coggins et al., 2007; Donaldson et al., 2008), so even a fish that is released alive may be dead within minutes to hours and it is unlikely that the mortality will be evident to the angler.

So what is best practice for hook removal? The use of hook removal tools (including simple pliers or hemostats) to aid hook removal for hooks that are in shallow regions (e.g. not in the gullet) are unlikely to cause mortality or undue injury. As avid anglers, such gear is always at the ready. However, evidence suggests that anglers avoid using any disgorgers for deeply hooked fish they intend to release and simply cut the line instead. If deep hooking is common, then it is encouraged that anglers consider trying circle hooks, artificial baits or being more attentive to fish interacting with baits to reduce likelihood of deep hooking. Unfortunately, the narrative used by most manufacturers and anglers that advocate for their use is that hook disgorgers are a panacea. That perspective is inconsistent with all available science on the topic, as well as knowledge on fish anatomy and where deeply set hooks tend to reside. Angling organisations, media and industry partners (e.g. fishing guides), and natural resource management agencies will all be needed to help reinforce this message. Efforts by the tackle industry to develop products that aid in release are laudable but must be rigorously evaluated to determine if they are indeed beneficial for the fish. However, individual angler behaviour and their willingness to "nudge" and educate others will be critical (Guckian et al., 2018). Further research is needed to understand what motivates anglers to practice certain fish handling and release practices, and how can these be changed to reduce catch-and-release mortality.

4 | AN ETHICAL CONUNDRUM

As noted earlier, the authors found themselves in an ethical conundrum with respect to continuing this study. Increasing sample sizes and conducting a statistically robust study seemed to be what the scientific community would demand (i.e. statistical conclusion validity; García-Pérez, 2012) and is one of the considerations by animal care committees when evaluating protocols (e.g. does one have sufficient sample sizes to generate robust statistical conclusions; Fitts, 2011a). Yet, continuing to conduct research that clearly has negative outcomes of fish welfare was inconsistent with animal care practices (Sloman et al., 2019). The approach used herein halting the study was not unlike what occurs in clinical drug trials where a phased approach is used and where full studies are often abandoned because of undesirable outcomes (Pocock, 1992, 1993). It is not uncommon to employ "stopping rules" in animal biomedical studies where studies cease if pre-specified outcomes are reached (Fitts, 2011b). The challenge, of course, is that fisheries managers focus on managing populations, so small sample sizes can lead to dismissal of findings given lack of ecological and management relevance (Cooke et al., 2016). As the authors reflect on this experience, they cannot recall another instance where they have halted a study because of concerns about fish welfare and research ethics. Nonetheless, the authors intend to incorporate sequential stopping rules (Fitts, 2011b) into future projects and suggest that such an approach might be particularly well suited to catch-and-release research given the emphasis on identifying opportunities for refining catch-and-release practices (Cooke & Schramm, 2007).

5 | CONCLUSION

This account is shared inasmuch as it emphasises the inherent tensions between the creativity and innovativeness of recreational anglers, the recreational angling trade (tackle manufacturers), and the responsibility of the scientific and management community. The fact that hook removal devices used to disgorge deeply set hooks can cause so much damage (and ultimately death) but are widely produced and available (and presumably purchased and used) should be a wakeup call for the recreational fishing sector to work collaboratively with the scientific community to identify best practices that truly benefit fish. Other studies on other types of angling tools and techniques by the authors have helped provide clarity about their efficacy (e.g. fish gripping devices, Danylchuk et al., 2008; landing net mesh types, Lizee et al., 2017), yet those studies were done in a bit of a vacuum when it comes to the angling industry. Moving forward, using this example of hook disgorgers for deeply hooked fish, more explicit partnerships among anglers, the angling trade, scientists and regulators are encouraged (see Cooke et al., 2017; Danylchuk et al., 2017), when it comes to evaluating whether tools created by the industry and angling community are worthy of use because of the benefits to the fish.

DATA AVAILABILITY STATEMENT

The small dataset is available upon request.

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