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SPECIAL ISSUE ARTICLE

Reflections on the influence of a synthesis of circle-hook evidence on the angling community and conservation policy and practice

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Abstract

1. Understanding how different forms of environmental evidence inform the actions of different stakeholders is useful to improve how we share knowledge with knowledge users. Reflections on a literature review that we published in 2004 on circle hooks as a tool for fish conservation in the recreational fishing sector identified a number of ways in which that synthesis was influential.
2. The article has had direct influence on policy and regulations in a number of countries, but there were even more examples of where the article has been used to influence voluntary guidelines. The article also contributed to formally defining circle hooks, which was necessary from a regulatory and enforcement perspective.
3. The recreational fishing community has also embraced the work, with numerous angling articles based on the literature review appearing in the media and with some angler organizations pushing for the adoption of circle hooks. The fishing tackle industry has also responded with evidence that circle hooks are now more widely available in stores with more hook design options to suit diverse recreational fisheries. In addition, the influence of the article has extended beyond the recreational sector to commercial fishery issues that span several taxa. The research agenda from the article helped to direct research for more than a decade and has since been updated.
4. Overall, this review was timely in that it provided various knowledge users with credible information synthesized in a thoughtful manner at a time when there was interest and need in exploring circle hooks as a tool to enhance the conservation of angled fish. Although this was not a systematic review, it still served as a form of evidence synthesis that gave diverse knowledge users information to guide them in their decisions.

KEYWORDS
circle hook, fishing gear, policy impact, recreational fisheries, stakeholder adoption

1 | INTRODUCTION

When engaging in applied ecology research related to the conservation and management of biological resources, it is implied that one should be doing research that is relevant to practitioners and decision makers (Memmott et al., 2010; Milner-Gulland et al., 2012). Yet, it is well known that there is a gap between those who generate new knowledge and the end users of that knowledge (termed the science–action gap, the knowledge–action gap, or the knowledge–implementation gap, among others), such that applied research performed with the intention of informing practice and policy often fails to do so. The reasons for the existence of this gap are many and have been studied by social scientists in an attempt to understand how the gap can be narrowed or closed (e.g. Cvitanovic, McDonald, & Hobday, 2016; Young, Nguyen, Corriveau, Cooke, & Hinch, 2016). A variety of guidance documents have been developed in an effort to help scientists generate research that is more actionable (e.g. Cook, Mascia, Schwartz, Possingham, & Fuller, 2013) and equip researchers with skills to exploit knowledge mobilization strategies that promote implementation (Reed, Stringer, Fazey, Evely, & Kruijsen, 2014; Young et al., 2016). Although there is much research underway in this sphere (Nguyen, Young, & Cooke, 2017), it is also possible to adopt a reflective approach in an effort to learn from successes and failures in one's own work (e.g. Arlettaz et al., 2010; Cooke, 2019).

In 2004 we published an article entitled 'Are circle hooks effective tools for conserving freshwater and marine recreational catch-and-release fisheries?' in *Aquatic Conservation: Marine and Freshwater Ecosystems* (Cooke & Suski, 2004). At that time, circle hooks had become popular among recreational anglers, based largely on the assumption that their use aids in the conservation of fisheries resources by reducing gut hooking, and hence mortality, but there were no syntheses on the topic, thus justifying our review. The article is an evidence synthesis (a quantitative literature review) that assembled knowledge (from peer-reviewed literature as well as grey literature, such as theses and government technical reports) on circle hooks and their use in recreational fisheries. The original article first presented a definition of a circle hook (the point of the hook is generally oriented to be perpendicular to the shank, the entire hook is rounded, and the shank is typically shortened, lending to the name 'circle hook'). Next, it described how circle hooks function and then quantified their role in conservation and fisheries management. A key conclusion from Cooke and Suski (2004) was that, on average, the use of circle hooks resulted in fish being hooked in shallower, less injurious locations in the mouth (rather than in the gullet), and therefore reduced mortality by approximately 50%, relative to conventional hook types. Despite these trends, however, factors such as hook size, fishing style, fish feeding mode, and mouth morphology all appear to affect the effectiveness of circle hooks. For these reasons, it is difficult to promote the adoption of the use of circle hooks as a panacea for all fish and fisheries. Instead, we recommended that management agencies focus on recommending circle hooks only for instances for which appropriate scientific data exist to support such an action. The article concluded with a research agenda as well as a synthesis of key points for fisheries managers, anglers, guides, outdoor media, and tackle manufacturers.

Since publication in 2004, the article has been cited 273 times (according to Google Scholar, 16 June 2019) and, to our knowledge, is the most cited circle-hook article of all time, averaging approximately 1.5 citations per month over the past 15 years. Of course, this is just one measure of impact and perhaps a poor measure of whether an article has truly influenced conservation policy and practice (Arlettaz et al., 2010). From the moment that we published the article, it has generated interest among a variety of audiences. Now, over a decade later, there is an opportunity to reflect on the ways in which the article has had influence, as well as providing some thoughts on the reason for such effects.

2 | IMPACTS ON POLICY AND MANAGEMENT

As an example of the regulatory influence of this synthesis, amendment 27 to the Gulf of Mexico Reef Fish Fishery Management Plan (GMFMC, 2007) explored several management options for minimizing the mortality of line-caught fish that were released. In 2008, the Gulf of Mexico Fishery Management Council mandated a strategy that recreational anglers fishing in federal waters were required to use circle hooks when catching reef fishes with natural bait (50 C.F. R. 622.41). In a subsequent report, it was noted that the regulation was '… supported by a comprehensive meta-analysis (i.e. Cooke & Suski, 2004), which reviewed 43 studies for 25 species and concluded that mortality rates were reduced by approximately 50% overall when circle hooks are used compared with J-hooks)' (Sauls & Ayala, 2012). Beyond regulatory approaches, many fisheries management agencies also share best practices with anglers via their websites and brochures. Both the Ontario Ministry of Natural Resources and Forestry (https://www.ontario.ca/page/catch-and-release-fish-handling) and the Illinois Department of Natural Resources (https://www.ifishillinois.org/catch_release/science.html) provide an overview of best practices, and highlight the Cooke and Suski (2004) article when encouraging anglers to use circle hooks in instances when anglers are using organic baits to fish passively. Clearly, this synthesis was noticed by conservation practitioners that drew from it when defining regional policy to protect a number of fisheries.

3 | IMPACTS ON THE ANGLING COMMUNITY

In addition to the policy impacts of this synthesis, the conclusions and recommendations from the article were noticed by the fishing community that followed the stated recommendations and changed their behaviour in order to maximize conservation benefits. More specifically, shortly after publishing the article its contents were summarized in a feature article in the leading fishing magazine *In-*

Fisherman (with a distribution of approx. 120 000 copies) and posted on their online site several years later (https://www.in-fisherman.com/editorial/circle-hooks-today/155104). The entire 600+ word article written by *In-Fisherman* is based on our review (which is prominently cited at the end) and linked to other feature articles in the same issue that helped anglers understand how circle hooks could be used to target different species. The article is also featured on the Wikipedia page for 'Circle Hooks', where it is used to serve as both the definition of the hook type as well as a summary of the benefits of using them (https://en.wikipedia.org/wiki/Circle_hook). The article has also been discussed on angler blogs (including in Italy, http://solomosca.blogspot.com/p/blog-page.html).

Some fishing tournaments for billfish mandate circle hooks, and use the Cooke and Suski (2004) article as justification for the practice (e.g. https://whitemarlinopen.com/hook-types). One website for a fishing-related non-governmental organization (NGO) cites the Cooke and Suski (2004) article to justify circle hooks as a tool that not only reduces mortality, but also allows for equal catch rates relative to conventional hooks (when used properly) (http://www.speakupforblue.com/commercial-fishing-using-circle-hooks-as-conservation-tool). Such messaging is important for encouraging the adoption of such a new conservation-minded gear type, and those data were presented in Cooke and Suski (2004). In addition, a variety of angling-based organizations have developed best practice guidelines to improve outcomes for angled fish, and have used the Cooke and Suski (2004) article as the basis for recommendations regarding circle hooks. The examples are wide-ranging: from the Outer Hebrides Fisheries Trust in the UK (https://www.outerhebridesfisheriestrust.org.uk/wp-content/uploads/2013/01/Impact-of-worming-on-the-survival-of-released-fish.pdf), to a cottager association in Ontario (Pointe au Barile Islander's Association, https://pabia.ca/the-type-of-hook-can-make-a-difference/), to a watershed-based organization in Quebec (i.e. Organisme de bassin versant du Témiscamingue) that produced an online brochure in both English and French (http://www.obvt.ca/fichiers/160210_Depliant_Remise_Eau_Final_OBVT_ANG_WEB.pdf). Together, the conclusions and conservation recommendations generated from this review have subsequently been adopted and promoted by the angling community, independent of mandated recommendations, demonstrating the power of this study to impact stakeholder behaviour.

4 | IMPACTS ON INDUSTRY

It is somewhat difficult to quantify the impact of the article on industry given that commercial organizations tend to be less transparent with their motivation for any product changes. It is worth noting, however, that since the article was published circle hooks have become more widely available (including for freshwater species), and are now found not only in specialist marine fishing stores but also in more conventional fishing stores and 'big box' retailers (Cooke, pers. observ.). In Australia, an industry-based aquatic animal health company have developed a set of best practices that they share on their website (http://panaquatic.com/projects/fishing-for-snapper/) that encourages the use of circle hooks based on Cooke and Suski (2004).

5 | INFLUENCE ON RESEARCH

Almost universally the Cooke and Suski (2004) article is cited in circle-hook recreational fishing studies in the introduction, noting that the synthesis revealed that there is a need for additional research in a greater diversity of species and contexts. As such, literally hundreds of subsequent studies draw from the framework outlined in this review and work to carry out the research agenda that was outlined. For example, as noted above, to support the Australian National Strategy for the survival of line-caught fish, researchers used the Cooke and Suski (2004) article to justify conducting a study on the sand flathead (*Platycephalus arenarius*) and the dusky flathead (*Platycephalus fuscus*) (http://www.imas.utas.edu.au/__data/assets/pdf_file/0011/743285/National-Strategy-for-the-Survival-of-Released-line-Caught-Fish.pdf). To support regulatory changes in the Gulf of Mexico, researchers justified the need for research by quoting the statement made by Cooke and Suski (2004) that '… [the article] cautioned that management strategies should not incorporate circle hooks unless studies confirmed that their use had benefits for the particular species of concern' (Sauls & Ayala, 2012). Of particular note, several studies have explored the human dimensions of circle hooks (Cooke, Nguyen, Murchie, Danylchuk, & Suski, 2012; Lynch, Sutton, & Simpfendorfer, 2010) – an explicit research agenda item identified by Cooke and Suski (2004) as hampering broader uptake. Thus, a great many researchers from academic, management, and other backgrounds, looking to maximize the survival of recreationally caught fish, turn to the conclusions of the review published by Cooke and Suski (2004) for guidance on conducting similar studies. In addition, the first (and only) International Symposium on Circle Hooks was held in Coral Gables, Florida, USA from 4 to 6 May 2011, and the Cooke and Suski (2004) article helped to frame many of the discussions. At that meeting the research agenda outlined by Cooke and Suski (2004) was updated (see Serafy et al., 2012).

6 | INSIGHTS FROM CITING DOCUMENTS

It is well established that citations are a poor measure of the influence of conservation research. Nonetheless, citation analyses can provide insight into the ways in which a given article has been used and is having some level of influence. As noted above, according to Google Scholar the article has been cited 273 times as of 16 June 2019. Using the 'cited reference search' feature of Google Scholar, we examined article titles and article source types (e.g. empirical peer-reviewed article, synthesis article, government technical report, etc.) to characterize the citing documents. We restricted our analysis to articles in English, French, and Spanish, and thus excluded

13 articles in other languages. One article was mistakenly listed twice, two documents were 'garbled', and one was a media article – these were also excluded. As such, we focused on the remaining 256 citations.

Twenty-five of the citations were for synthesis or perspective articles (published in peer-reviewed outlets) related to recreational catch-and-release science, whereas 90 of the articles were empirical studies of catch-and-release angling (mostly studies comparing circle hooks to other hook types in a range of gamefish) published in peer-reviewed outlets. Interestingly, there were six citing articles that focused on the human dimensions of circle hooks (for an example of evaluating angler perspectives on circle-hook-related regulations, see Veiga et al., 2013; for an example of angler preferences for striped bass management options, see Murphy et al., 2015), an important aspect of operationalizing scientific research, and that used the Cooke and Suski (2004) article as justification for exploring circle hooks as a management option. There were an additional seven graduate theses citing the article in the context of recreational fisheries as well as five government synthesis documents (e.g. Casselman, 2005; Patterson et al., 2017; including the UN FAO (2012) technical guidelines for responsible recreational fisheries that used the Cooke and Suski (2004) article to suggest that they are a tool for reducing hooking mortality), 17 government technical/policy reports (e.g. Meyer & Homer, 2007; Burns, Brown-Peterson, & Overstreet, 2008; Harding & Coyle, 2011 – often specific assessments of circle hook performance for a given fishery), and one imperilled species assessment report (i.e. Stevens, Pillans, & Salini, 2005; discussed in the context of circle hooks as an appropriate assessment tool for a group of imperilled fishes).

Although the Cooke and Suski (2004) article focused on the recreational fisheries sector, the article has had some influence on research surrounding the commercial long-line fishery sector (as well as the inland trotline or drumline fishery, to a lesser extent). Thirty-one studies explored circle-hook performance relative to other hook types for commercial fish. An additional nine studies were specific to reducing the by-catch of turtles, as well as one on whales, one on the mudpuppy (*Necturus maculosus*), and one on birds (all in peer-reviewed journals). There were an additional 15 studies focused on longlines that were published as government technical reports and two graduate theses.

7 | REFLECTIONS

While reflecting on the impact of Cooke and Suski (2004), we identified three main reasons why the article has had such a demonstrable influence on both policy and practice. First, at the time, there simply were no evidence syntheses on the topic of circle hooks until we conducted this review. Evidence syntheses serve important roles in assembling the evidence base and distilling it in an effort to identify patterns and trends that can be informative to managers looking to apply an intervention to a species/fishery. Walsh, Dicks, and Sutherland (2015) revealed that decision makers rely heavily on evidence syntheses in that they are a more robust approach than relying on a single empirical study. That said, evidence syntheses are performed with various levels of rigour, and thus have the potential to be biased (Haddaway, Woodcock, Macura, & Collins, 2015).

Second, although the Cooke and Suski (2004) article was not a systematic review and did not include a critical appraisal phase (Haddaway & Bilotta, 2016), it did do an exhaustive search and includes both traditional and grey literature. Moreover, the data used in the analyses are all reported in a table in the article, thus providing a level of transparency. It would be interesting to conduct a follow-up study using more rigorous systematic review standards (e.g. Collaboration for Environmental Evidence, https://www.environmentalevidence.org/information-for-authors) given that the evidence base has expanded greatly since 2004.

The third reason why we feel that this article has been so impactful is that the article concludes with a clear management direction, yet also discusses uncertainties and the extent to which extrapolations should be made. Such candour is useful for decision makers. In hindsight, it would have been worthwhile to prepare a short (two-page) policy brief (Masset, Gaarder, Beynon, & Chapoy, 2013) to accompany the article, in that it is known that many decision makers prefer to consume evidence in the form of short yet evidence-based briefs. It would also have been informative to produce an infographic to highlight key messages in a visual manner (Smiciklas, 2012). In 2004 social media was in its infancy, so this type of science communication would not have had the impact that it does today. Together, the timeliness of this publication, the thoroughness of the review, and the clear direction forward (along with meaningful caveats) have all contributed to the fact that this article has served as a portal that cogently distilled the existing literature, while charting a path forwards for both research and good practice.

8 | CONCLUSION

The article we wrote some 16 years ago was the first to synthesize the role of circle hooks in reducing the mortality and injury of angled fish. The review was not commissioned or funded, so we generated it with the assumption that there was a need for such an article, and that it would be of use to anglers and fisheries managers. In fact, we were both postdoctoral researchers when we wrote this article and it has benefitted our careers in that it identified us as experts on a specific topic of international and applied relevance (e.g. leading to a plenary invitation for Cooke at the International Symposium on Circle Hooks at an early stage of his career). We had a number of early 'wins', given that many jurisdictions were considering circle-hook regulations and anglers were curious about this topic. Our article collated the relevant research and synthesized it to reveal general patterns that were of use to managers. We also created a research agenda that was apparently embraced by those who conducted empirical circle-hook research and have cited us since then. Since the publication of

this article we have become more skilled in science communication (Cooke et al., 2017) and knowledge mobilization (Young et al., 2016), and the influence and impact of our work would have been much greater if we had engaged more fully in such activities. Nonetheless, clearly our article did have influence. We hope that others learn from our experience and emphasize that, although it is rare for a single article to influence policy and practice (Arlettaz et al., 2010), in this case we conducted a synthesis (see Walsh et al., 2015) that 'hooked' practitioners and policymakers far beyond the reach that we had anticipated.

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