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# Guidelines for evaluating the suitability of catch and release fisheries: Lessons learned from Caribbean flats fisheries

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ABSTRACT

Catch and release is receiving attention as a recreational fisheries conservation tool, but data are often lacking on: the suitability of target species; location-specific factors (e.g., predator field); likelihood of community support; infrastructure capabilities; availability of suitable habitat. This is especially true where C&R fisheries are being developed because they are perceived as economically valuable, automatically self-sustaining, with low environmental impact. However, resources to support research, management, and enforcement are often lacking, leading to fisheries that are de facto C&R, with little oversight or conservation planning. This can lead to fisheries that are not sustainable due to low post-release mortality, overfishing, loss of critical habitats. In locations with limited resources, a framework is needed to maximize these resources to provide sufficient information for fisheries management and evaluation. The "flats fishery" of the Caribbean, comprised of bonefish (*Albula vulpes*), Atlantic tarpon (*Megalops atlanticus*), permit (*Trachinotus falcatus*), and common snook (*Centropomus undecimalis*), supports an economically valuable recreational fishery that is C&R in many locations throughout its geographic range. Once a fishery that received little management attention, recent research has provided sufficient information to guide conservation and management. In this manuscript, the lessons learned from >10 years of research and conservation of the Caribbean flats fishery are used to demonstrate how C&R Fishery Evaluation Guidelines (FEGs) can be applied to this and similar C&R fisheries. The FEG factors include: species suitability, habitat, water quality, fishery status, fishery capacity, socio-economics, enforcement and compliance, cultural factors, and education.



## 1. Introduction

Catch and release (C&R) has become a common practice in recreational fisheries despite an overall lack of data on the effectiveness of C&R in recreational fisheries management (Arlinghaus et al., 2007). C&R is practiced voluntarily by anglers as a conservation ethic (Arlinghaus et al., 2007), used as part of an overall management strategy (Bartholomew and Bohnsack, 2005; Arlinghaus et al., 2007), and in some cases a fishery becomes *de facto* C&R due to strict harvest regulations (e.g., Taylor et al., 2001). Given the success of C&R in some fisheries, C&R has even been proposed as a focus of marine protected areas (e.g., Ley and Allen, 2013), but at present there are insufficient data to warrant the coupling of C&R and MPAs as a management strategy (Cooke et al., 2006). Indeed, data on the effects of C&R are lacking for many species, and species-specific guidelines are needed to replace generalized C&R guidelines (Bartholomew and Bohnsack, 2005; Cooke and Suski, 2005).

Because of the perceived benefits of C&R, such fisheries are receiving increasing interest as conservation tools (Adams and Murchie, 2015) supporting sustainable economies associated with ecotourism (Zwirn et al., 2005). The implicit assumptions are that C&R fishing has high economic impact, can be accomplished with relatively little infrastructure and investment, needs little management because the fish are released rather than harvested, and has low environmental impact. To the extent that these assumptions are valid, C&R recreational fishing is viewed as an important component of ecotourism and can make significant economic and conservation contributions if managed appropriately (Zwirn et al., 2005). Given that recreational fishing is becoming more popular, however, and that anglers are seeking and will continue to seek new fishing opportunities, often in Low- and Middle-Income Countries (LMIC) (Cowx, 2002), care must be taken to ensure that C&R fisheries are sustainable, appropriate conservation measures (e.g., habitat protection) are in place, and socio-cultural factors are taken

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into consideration when developing or managing C&R fisheries (Arlinghaus et al., 2007).

The assumption that C&R is universally viable sets a dangerous course for some fisheries. Since estimates of post-release mortality range from near 0% to 90% (Muoneke and Childress, 1994), it is critically important that species suitability for a C&R fishery is examined. Indeed, even for species that generally have high post-release survival there are qualifiers, including predator field (Cooke and Philipp, 2004), water temperature (Brownscombe et al., 2015), and water depth (reviewed in Bartholomew and Bohnsack, 2005). So while there are general C&R practices that can be applied for all species to increase post-release survival, more specific information on C&R is still needed (Cooke and Suski, 2005), including species, location, and season. For example, the estimated post-release survival of bonefish ranged from 95% in a location with few predators to 61% in a location with many predatory sharks (Cooke and Philipp, 2004).

The objective of this paper is to use the Caribbean "flats fishery" – which focuses on bonefish (*Albula vulpes*), Atlantic tarpon (*Megalops atlanticus*), permit (*Trachinotus falcatus*), and common snook (*Centropomus undecimalis*), is frequently C&R, and has received >10 years of research and conservation focus – as a case study to propose a framework for assessing new and established C&R fisheries, especially in Low- and Middle-Income Countries (LMIC) with limited financial or infrastructure resources, as occurs in much of the Caribbean where the C&R flats fishery occurs. This framework is the C&R Fishery Evaluation Guidelines (FEGs). Studies on the species of the Caribbean flats fishery are placed in the context of the FEGs to demonstrate the type of knowledge that is being used to evaluate and monitor this C&R fishery, and to provide guidance for evaluation and monitoring of C&R fisheries in other locations.

## 2. C&R fishery evaluation guidelines

The goal of the C&R Fishery Evaluation Guidelines (Table 1) is to provide a structure for identifying and assessing factors important to the creation, maintenance, and management of C&R fisheries by helping to recognize areas of concern and examine interactive effects (e.g., habitat health, post-release mortality, and fishery capacity interact to affect fishery sustainability). The factors within the FEGs framework allow an iterative approach to identifying information deficiencies on which to focus research and conservation efforts, formulation of strategies that proactively address the most likely items to cause problems, and monitor the fishery over time. These guidelines will help structure the much needed long-term monitoring of C&R fisheries to evaluate fishery impacts (Cooke and Cowx, 2004), and incorporate the multiple biological and socio-cultural factors that must be included in management of C&R fisheries (Arlinghaus et al., 2007).

The challenge in creating the FEGs was to make it as parsimonious as possible but still be effective – i.e., to include enough factors to achieve a valid evaluation while avoiding the temptation to make the guidelines too unwieldy by adding too many factors, and thus setting an unachievable goal. Although the desire scientifically is to obtain the highest level of knowledge for all aspects of C&R and fisheries conservation for each target species, this is frequently not achievable for locations with limited resources. This is especially true in LMICs, where resources for conservation and management are limited (Adams et al., 2013; Cowx, 2002). Instead, the FEGs present a framework to use research to provide resource managers with 'actionable knowledge' that can be applied to management: actionable knowledge is defined as "the creative intersection between what we know and putting what we know into everyday practice" (Blood, 2006). The factors that make up the FEGs were deemed most important following research and conservation of the Caribbean flats fishery, so are suggested as the best combination for a standardized approach to fishery evaluation. However, it is expected that location-specific dynamics will influence how factors are prioritized, and even the addition of new factors.

### 2.1. Biological factors

#### 2.1.1. Species suitability – response to catch and release

The major factors affecting post-release survival of bonefish involve the amount and type of handling by anglers, exposure to air, duration of the fight, and abundance of predators at the release location (Cooke and Philipp, 2004; Danylchuk et al., 2007a,b). When bonefish are improperly handled and exposed to air for extended durations, their mortality increases significantly (Danylchuk et al., 2007a,b). In areas with few predators, the post-release survival of properly handled fish is >95% (Cooke and Philipp, 2004; Danylchuk et al., 2007a), but can drop to 61% if predatory sharks are abundant (Cooke and Philipp, 2004). Since angler behavior is so influential to post-release survival, considerable effort has been put into a recurring angler education program to instill proper handling practices and to alter angler behavior to avoid fishing in areas with abundant predators.

Tarpon are similarly suitable for C&R if proper handling techniques are used and locations with high predator abundance are avoided. Large tarpon (> 1 m Fork Length) show physiological stress with handling, whereas tarpon <1 m FL exhibited little physiological stress due to handling (Guindon, 2011). As with bonefish, predator abundance increases C&R predation. The estimated post-release mortality for tarpon on the Gulf of Mexico coast of Florida is 5%, but predation by sharks increases post-release mortality to 13% (Guindon, 2011). A significant portion of the shark predation occurs in areas where high fishing effort targets seasonal tarpon aggregations that occur during spawning season, where shark abundance is often high. Much of this predation occurs after hooking and before landing the fish, so has been difficult to measure and is not included in the post-release mortality estimates (Guindon, 2011). Our knowledge of the effects of C&R on tarpon suggest that they are suitable for a C&R fishery, but that additional research is warranted to better understand the population-level effects on a species that is long lived (to 80 years) and late to mature (8–12 years of age), which may make tarpon susceptible to population reductions (Adams et al., 2013) due to modest levels of C&R post-release mortality. As with bonefish, angler education is essential to modifying angler behavior to increase fishing-related mortality (e.g., avoid fishing in areas with high shark abundance).

More than 90% of common snook captured in Florida are released, and overall post-release mortality was estimated at 2.13%, with mortalities attributed to hook placement (Taylor et al., 2001). Since the snook were held in isolated water bodies after capture, predation was not included in the analysis, so the actual post-release mortality is likely higher. However, angler reports of post-release predation of snook in Florida are rare. Snook experienced no mortality during treatments that examined the effects of handling and tagging (Taylor et al., 2001), and C&R did not appear to disrupt spawning (Lowerre-Barbieri et al., 2003).

Sufficient information on the immediate effects of C&R on Caribbean flats species is available to meet the standard of actionable knowledge for fishery conservation, but data gaps exist and must be addressed. Data deficiencies exist on the cumulative effect of multiple C&R events, sub-lethal physiological effects, and fitness impairments (Cooke et al., 2002), which is true for most fish species (Cooke and Suski, 2005). In addition, data on the effect of C&R on spawning are needed for bonefish, tarpon, and permit, since these species aggregate as part of the spawning process, so may be vulnerable to C&R associated physiological effects, disruption

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