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Testing fisher-developed alternatives to fishery management tools for community support and regulatory effectiveness

Liam M. Carr [a,*], William D. Heyman [b]

[a] Department of Geography, TAMU 3147, Texas A&M University, College Station, TX 77843, United States
[b] LGL Ecological Research Associates, Inc., 1410 Cavitt Ave., Bryan, TX 77801, United States

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ABSTRACT

This research develops a methodology to evaluate public support for fishing regulations, comparing existing regulations designed without much public input, to possible alternative regulations based fishers' ecological knowledge (FEK) and preferences. First, a survey and open-ended interview was completed with 42 fishers in St. Croix, U.S. Virgin Islands (33% of the total number of currently registered commercial fishers on island) regarding general matters of fishery health and productivity, with heightened focus on the management of a mutton snapper (*Lutjanus analis*) spawning aggregation. The interview results suggest that fishers view management tools in terms of spatial and temporal parameters, and how much those regulations influence gear selection. Fishers respond primarily to socio-economic pressures, but recognize and support ecological goals of regulations, particularly those that provide protections to important stocks throughout their spawning season. A Discrete Choice Model (DCM) was developed based on the results of the fisher surveys and was administered to 182 individuals, including 54 residents of St. Croix and all 42 fishers interviewed. Eight DCM options were presented to respondents who selected their regulatory preference in a pair-wise fashion. In seven of eight pairs, public respondents selected fisher-preferred, FEK-based regulatory frameworks. These results suggest FEK can be used to develop fishery regulations that will meet management goals, and be broadly supported by both members of the fishing community and the general public. In this manner, ecosystem-based management frameworks can be improved by incorporating fishers and their FEK, particularly for small-scale fisheries.

1. Introduction

1.1. Value of fishers' ecological knowledge in ecosystem-based management

Fisheries management is moving from traditional regulatory approaches that focus on single species and on reducing fishing effort incrementally [72] to human-focused, holistic, ecosystem-based management (EBM) approaches [57,7]. Such an approach recognizes that fishery uncertainty cannot be fully reduced or overcome [66], that the majority of uncertainty lies not in scientific understanding of fishery processes but in human behavior [14,30], and that well managed, functional ecosystems produce sustainable streams of goods and services [12,46,47]. Furthering this shift at local levels and particularly with small-scale fisheries (SSFs), the benefits of incorporating fishers' ecological knowledge (FEK) has shown promise and a possible way forward for developing and improving management at relevant scales [13,36,56,6].

FEK can be utilized within a management setting as a qualitative substitute for describing a fishery's functionality and trends over time [14,67]. FEK possesses value at local scales despite a lack of scientific rigor [36], and may be the only form of knowledge for many “data-poor” fisheries [14,24,35,57]. It is built upon fishers' work in a fishery, their observations of stock behaviors and changes, and the social and economic demands placed on fishers in their daily quest to be profitable in the fishery [4]. FEK can help research and monitoring efforts by identifying essential fish habitat [5], describing trends in stock abundance and seasonal movements [14], and providing general descriptions on habitat and marine community health [36]. FEK and fisher behavior can present a near real-time assessment of the fishery that traditional monitoring or research programs cannot remotely mimic, providing a uniquely valuable information source for management

* Corresponding author. Present Address: Whitaker Institute, Room 307, J.E. Cairns School of Business and Economics National University of Ireland, Galway, Ireland.
E-mail address: liam.m.carr@nuigalway.ie (L.M. Carr).

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and policy development [8,62,67].

The ability of FEK to identify and describe essential fish habitat (EFH), in particular, has shown great promise within EBM frameworks [5,69]. EFH in the United States is defined by provisions within the Magnuson–Stevens Act [55] to be "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 CFR §600.10). [41] offer a critique of the utility of this definition as "the ability of fisheries managers to identify EFH depends on knowledge of what habitats fish use… However, since all habitats used by all life history stages are included in EFH descriptions, [EFH] is defined very broadly." FEK can be used as a substitute in instances where managers cannot describe or prioritize among areas identified as EFH. This ability is perhaps most valuable for situating no-take marine protected areas (MPAs) in locations to maximize ecosystem benefits.

1.2. Marine protected areas in small-scale fisheries

Properly designed and enforced, EBM-based MPAs offer protections for a full suite of ecological services and functions in a manner that other tools cannot [25], making the health of the ecosystem the primary management concern [57,68]. Even in instances where data is limited, establishing an MPA at purported EFHs may provide some level of protection above having none [19,33,35]. By affording protections to both targeted and non-targeted, "ecosystem-component species" [53], MPAs are different from other direct and indirect regulatory controls that tend to focus on single-stock management [26]. In SSFs where effort targets many different species with several different gears in the same trip, the general ecosystem-level focus of MPAs may ultimately lead to greater management outcomes [25,35,63,66], although their establishment and maintenance may be highly difficult due to social and economic forces [18,58,63]. Indeed, MPAs have become over the past decade a preferred management strategy for large-scale [27] and local-scale [31,48,59] fisheries and as a valuable tool that can support EBM. MPAs can effectively reduce the need for data-reliant decision-making by accepting that fishery dynamics, while not fully described or understood, are likely maintained at some functional level inside the reserve. Such functional resilience [57] is an important concern, as it helps guard against regime shifts [28] or cascading trophic effects [65] that result from secondary impacts of overfishing through a reorganization of the remaining community.

MPA can also provide much-needed help in improving limited enforcement capabilities of SSF management. This is because MPAs are discretely defined spatially, while SSF fishing effort and markets in SSFs tend to be highly dispersed in both space and time [64]. Fishers vary effort and ground selection daily or even several times over the course of one trip.

MPAs are thought to be capable of returning ecosystem service benefits, including fisheries that are several orders of magnitude larger than the loss of the area to fishing [43]. Even at scales smaller than the prescribed 20% coverage [11], properly designed and implemented MPAs, and networks of MPAs, have improved fishery stocks and been central to maintaining healthier marine communities and generating community support and the development of alternate economic opportunities [34,59].

Finally, the development of MPAs allows managers and fishers a rare opportunity to work together. In data-poor SSFs, fishers possess the necessary knowledge and experience to identify grounds that serve as EFH and that should receive priority for protection. Through their FEK, fishers can recognize specific sites of productivity within a larger fishing ground that are otherwise difficult, if not impossible, to locate without first-hand knowledge of where and when to fish because of the small scale of exploitation [14,36]. As a result, FEK and fishing behavior may be one of the greatest tools that data-poor SSFs possess for developing and successfully implementing a management framework [13], particularly with regards to the development of MPAs.

1.3. Utilizing fishers' ecological knowledge to examine regulatory design

As a case study for testing the ability of incorporating FEK into regulatory design, this research focuses on the coral reef fishery of St. Croix, U.S. Virgin Islands. St. Croix has long supported a vibrant, locally-important, small-scale commercial fishery focused on queen conch (*Strombus gigas*), Caribbean spiny lobster (*Panulirus argus*), and several families of demersal and pelagic fishes [39], particularly scarids (parrotfishes), serranids (groupers and hinds), lutjanids (snappers), and balistids (triggerfishes). Developing and implementing a sustainable management program within the territory, however, has been hindered by a lack of suitable fisheries data and the necessary support for proposed regulations by stakeholders [15,16,51]. While resource managers and fisheries scientists have spent much of the past several years developing management directives to have U.S. Caribbean fisheries comply with the Magnuson–Stevens Fisheries Conservation and Management Act [52], little meaningful work has been done apart of Kojis' [39] fisher census to assess the potential of including territorial fishers and their unique knowledge and skill sets into the deliberative process. Each island's fishery through the U.S. Caribbean is unique [39], with the commercial fishery in St. Croix being predominantly scuba-assisted. Fishers dive throughout the open seasons for conch and lobster while opportunistically spearfishing [13,14]. While not nearly as dominant a gear as in St. Croix's sister island of St. Thomas, several fishers use traps to capture deep reef fish species [1], and several target pelagic fishes, particularly mahi (*Coryphaena hippurus*).

What becomes immediately clear from the perspective of fisheries management programs is that the multi-gear, multi-target Crucian fishery cannot be well managed using single-gear and single-species approaches [15,16]. St. Croix's commercial fishery has been characterized as open-access, having endured unsustainable fishing gear selection, coupled with low compliance with existing regulations, weak enforcement, and an ineffective licensing mechanism that serves to exacerbate issues of overfishing [21–23,39]. When these issues are added to the ongoing losses of EFHs throughout the U.S. Caribbean region [23,44,45,49,54,60,61], the risk of commercial fishery extirpation in St. Croix is real.

The existing regulatory regime on St. Croix is viewed by managers and numerous stakeholder groups, especially commercial fishers, as ineffectual in dealing with the myriad concerns facing the island's marine resources [23,32]. Short on enforcement capabilities, St. Croix's fisheries management is dependent upon fisher compliance and self-enforcement, yet fishers remain largely excluded from the planning and review of research, data, and regulatory development. While this exclusion is often self-inflicted by fishers too pessimistic with the state of their fishery and regulations, there are other factors that prevent fishers from fully engaging, e.g. geographic issues (i.e. meetings are not always held on St. Croix) and economic issues (i.e. attending the meetings prevents them from fishing at the same time) [13].

This study uses a case study approach focused on the management of mutton snapper (*Lutjanus analis*) in St. Croix to examine if FEK-based regulatory alternatives will be supported publicly. Mutton snapper is presently managed through a seasonal MPA and a "no fishing/no-possession" closed season during its vulnerable spawning season. To do so, the opinions and FEK of commercial fishers on existing regulations and possible alternatives are evaluated through interviews. These data are then