Addressing Unsafe Dive Profiles in a Small-scale, Multi-species SCUBA-based Dive Fishery in the Eastern Caribbean

Revisando los Perfiles de Buceo Peligrosos una Pesqueria de Buceo Multi-species de Pequeña Escala, Basado en Pesca de Buceo en el Caribe Oriental

S'adressant là des Profils de Plongée Dangereuse à Petite Échelle, Multi-espèces Plongée Basé Pêche Plongée dans les Caraïbes Orientales

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EXTENDED ABSTRACT

Introduction

Dive fisheries are fishery systems in which fishers use compressed air to harvest marine living resources in the quest for livelihoods. Dive fishers around the world target a wide range of primarily high-value, benthic species of echinoderms, crustaceans, molluscs as well as fish (for consumption and ornamental use), algae and sea turtles (Ehrhardt 2006, Eriksson et al. 2012, Forman 2005, Halim 2002, Gold et al. 2000, Lepawsky and Wong 2001, Nayar et al. 2009, Ruffez 2008, Westin et al. 2005). Self Contained Underwater Breathing Apparatus (SCUBA) or surface compressor supplied air (hookah) are the two systems used in dive fisheries (Blatteau et al. 2015, Eriksson et al. 2012, Vann et al. 2011).

The use of compressed air diving renders what has long been considered one of the world's most dangerous occupations an even riskier proposition (Ben-Yami 2000, Vann et al. 2011). Decompression illness is the result of excessive nitrogen accumulation in the bloodstream coming out of solution in the form of bubbles when safe no-decompression dive limits are exceeded or other dive protocols violated (Tetzlaff and Thorsen 2005). Other risks in dive fisheries include barotraumas, drowning and being lost at sea (Elliot and Moon 1993, *Pers. obs*.). In some dive fisheries, dizziness, bleeding from the ears, partial paralysis, and deaths are not considered uncommon (Blatteau et al. 2015). The physiology of diving presents unique risks to fishers not seen in other types of fishing and result in an activity with direct trade-off between human health and fishing effort. The longer or deeper fishers spend under water, the greater the probability of experiencing an incident of decompression illness (Hempleman 1993).

While the health impacts of decompression injuries and barotraumas from this trade-off have been well established in small-scale dive fisheries of the developing world, broader study of these unique fisheries remain largely unexplored (Barratt and Van Meter, Blatteau et al. 2015, Gold et al. 2001, Huchim-Lara et al. 2015). Addressing the health, conservation and management concerns of dive fisheries will be predicated, in part, on knowing why fishers undertake unsafe dive profiles.

The complexity of dive fishery systems is also further complicated by the fact that resources targeted by dive fishers may be in states of or at risk of over-exploitation (e.g. conch, lobster, sea cucumber) or at risk of local, sequential depletion (Pakoa and Bertram 2013, CRFM 2011, Luckhurst and Auil-Marshalleck 1995). This study focused on the SCUBA-based Caribbean Spiny Lobster (*Panulirus argus*) and Queen Conch (*Lobatus gigas*) dive fishery in the Eastern Caribbean tri-island state of Grenada, Carriacou and Petit Martinique. Forman (2005) conducted an epidemiological survey of diving related morbidity and mortality in the Grenadian fishery; this study provides a socio-economic and ethnographical context to Forman (2005).

Methodologies

The ethnographic methodology consisted of field interviews with fishers that were supplemented by direct as well as participant observation of fishing methods. A total of 30 out of a total population of approximately 85 fishers were interviewed across all six main dive-fishing communities in the tri-island state (Calliste, Woburn, Grenville, Sauteurs, Hillsborough, Petit Martinique) over a period of six-weeks. Interviews were semi-structured, qualitative in nature and focused on understanding how divers learned to dive, how they understood and perceived diving risk, their experiences with dive injuries and how they perceived changes in the fishery over time. The principal investigator participated in two dives with fishermen to complement both interview data and direct observations of the fishery. One dive was conducted with lobster fishers and one dive with conch fishers. Interview responses were analyzes using a thematic, grounded theory based analysis reinforced and validated by direct and participant observations.

Results

All respondents were male with an average age of 49.4 years and 18.8 years of diving. Reflecting findings by Forman (2005), the rate at which fishers experienced diving injuries have effectively not changed. The study identified two primary categories that drive unsafe dive profiles: economic and ecosystem drivers. Economic drivers consisted primarily of

uncertainties surrounding the unstructured market in which fishers compete at disadvantageous bargaining positions for both buyers and price. It is these and other lesser economic drivers that require fishers to maximize the time available to process and sell catch. As a result the diving day is consists of four to five dives to depths of 18 - 40 m that is conducted in the span of less than 4 - 5 hours, including transit time to and from fishing grounds. These are compounded, to an undetermined degree, by both inter- and intra- seasonal depletion of lobster and conch stocks, localized depletion and broader changes to the health of ecosystems, as identified by fishers through interviews. This has resulted in greater fishing effort for less catch than was first required when the fishery was established in the 1970s combined with diving that has to occur deeper and further offshore, particularly where lobster is concerned.

Vulnerabilities that may impact fishers, but not act as drivers of unsafe dive behavior were also identified in this study. A key example is the lack of a hyperbaric chamber on the island to deal with injured fishers; its absence is in fact likely a deterrent for riskier dive practices (Forman 2005). Risk factors such as operating vessels or diving while intoxicated, while uncommon, were also identified as areas that could be addressed to mitigate existing diving risks.

Conclusions and Recommendations

Fisheries managers have three options to address the unsafe practices in the fishery: ban diving altogether, regulate it (or enforce existing regulations), or address the underlying drivers of unsafe dive behavior. The first option, though not impossible, would appear politically untenable in the Grenadian dive fishery in the absence of suitable livelihood alternatives while regulating it would significantly tax already burdened authorities for what is a relatively small fishery though economically important fishery.

A co-operative based co-management arrangement would likely provide the most suitable pathway to dealing with the economic uncertainties present in the fishery, particularly those that lead to short diving days in order to allow fishers time to process and sell catch. In this respect, a co-operative could act as a clearinghouse within appropriate regulatory framework to redress disadvantageous bargaining positions and relieve diving pressures. Additional, benefits could also include sharing resources when searching for lost-at-sea fishers, improved training and knowledge sharing as well as supporting injured divers who can no longer fish. However, these would not be without its challenges as co-management in Grenada has not been without its difficulties (McConney and Baldeo 2007). Therefore carefully consideration would need to be made in nurturing this process (Chuenpagdee and Jentoft 2007).

Such an arrangement would need to occur with a broader strategy to address livelihood vulnerabilities. While fishers are known to respond to resource availability by switching livelihood strategies, it is unknown at which point risk becomes too great for fishers and when they might choose an alternative livelihood approach (Allison and Elis, 2001). Given that the current situation remains largely unchanged since Foreman (2005), the rates of morbidity and mortality in the Grenadian dive fishery would likely have to increase before fishers were to switch to another occupation. Fisheries managers also have the ability to pick low-hanging management fruit by dealing with existing risk factors as it relates to diving, such as providing enhanced dive training and making emergency medical oxygen available at key landing sites. Such measures would however be short-term stopgaps and likely prove ineffective if the underlying causes are not dealt with.

Environmental drivers of unsafe dive profiles can be addressed through better management of the fisheries while addressing long-term changes to marine ecosystem that may drive risk taking (Miloslavich et al. 2010). Co-management, alongside with broader, existing marine conservation efforts, would allow fishers to play a greater role in management of these resources thus effectively working to reduce the pressures that cause them to dive the way they do today.

It would appear, at face value, that diving for marine living resources using compressed air is incompatible with fishing. However, successful dive fisheries exist, such as the abalone dive fishery in Australia (Haddon et al. 2013). Furthermore, diving has the potential to deliver highly selective, environmentally friendly hand-harvested fishery practices (Lenihan and Peterson 2004). Therefore there is no reason that high-value Caribbean Spiny Lobster and Queen Conch dive fisheries could not both be labor friendly and sustainable under the appropriate economic and management regimes.

KEYWORDS: SCUBA fishery, decompression injury, fisheries management, cooperative, Grenada

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