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Global evaluation of shark sanctuaries

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ABSTRACT

Due to well-documented declines in many shark populations there is increasing pressure to implement new management and rebuilding strategies at the national and international scale. Since 2009, fifteen coastal countries in the Atlantic, Indian and Pacific Oceans have opted to ban commercial shark fishing altogether, and have laws that prohibit the possession, trade or sale of sharks and shark products. These 'shark sanctuaries' collectively cover > 3% of the world's oceans, a similar coverage as all currently established marine protected areas combined. Despite their prominence, and an intense scientific debate about their usefulness, the condition of shark sanctuaries has not yet been empirically evaluated. Here, we report results from a global diver survey used to set baselines of shark populations, human use patterns, public awareness and threats in all 15 shark sanctuaries, and contrasted with observations from 23 non-sanctuary countries. Specific results varied by country, but there were some general trends: i) shark sanctuaries showed less pronounced shark population declines, fewer observations of sharks being sold on markets, and lower overall fishing threats compared to non-shark sanctuaries, ii) bycatch, ghost gear, marine debris and habitat destruction are significant threats that are often not addressed by sanctuary regulations and need to be resolved in other ways, and iii) participants in sanctuaries were more optimistic about the survival of shark populations in local waters, but also highlighted the need for further conservation efforts. These results suggest that shark sanctuaries, as seen through the lens of local experts, may be a helpful conservation tool but likely not sufficient in isolation. There is an urgent need for higher-resolution data on shark abundance, incidental catch, and markets to direct priority conservation needs and optimize the conservation benefits of existing and future shark sanctuaries.

1. Introduction

Around the world, targeted fisheries and bycatch have reduced numerous shark populations to a fraction of their unfished abundance (Dulvy et al., 2014, 2008; Oliver et al., 2015), and rendered nearly one third of species vulnerable to extinction (Dulvy et al., 2014). Despite growing awareness and concern, shark mortality rates may still exceed reproductive rates in many regions (Worm et al., 2013). In addition, the threats of illegal, unreported and unregulated fishing (IUU) represent significant regional management challenges (Agnew et al., 2009; Clarke et al., 2006; Worm et al., 2013).

Recognizing these threats to sharks, as well as the growing value of non-extractive uses (Cisneros-Montemayor et al., 2013; Gallagher and Hammerschlag, 2011), has led some coastal countries to implement laws that ban shark fishing within their entire economic exclusive zones (EEZ) and prohibit the possession, sale, or trade of sharks or shark parts, with some limited exceptions for local consumption (Ward-Paige, 2017). At the time of writing, fifteen countries had declared their EEZ as so-called shark sanctuaries. The primary goals (where stated) are to protect and, where necessary, recover shark populations nationwide by reducing fishing mortality to near zero, and to eliminate the local contribution to the global supply chain of shark products (Ward-Paige, 2017).

With the first national shark sanctuary being declared in 2009 by Palau, and 14 other countries following suit, the total area covered by shark sanctuaries now exceeds 3% of the world's oceans (Ward-Paige, 2017) – similar to the total coverage of marine protected areas worldwide (Lubchenco and Grorud-Colvert, 2015). The majority of this coverage is in Oceania, followed by the Caribbean and the Indian Ocean (Maldives) (Fig. 1). A summary of existing shark sanctuary regulations (Ward-Paige, 2017) shows that countries that have implemented shark sanctuaries are diverse in terms of socio-economic factors, but marine tourism is an important industry for most; sharks are explicitly defined by only six countries, while some also include rays under full protection details of protective measures vary among countries where, for example, it may be "illegal to catch, keep in captivity, trade, or harm any

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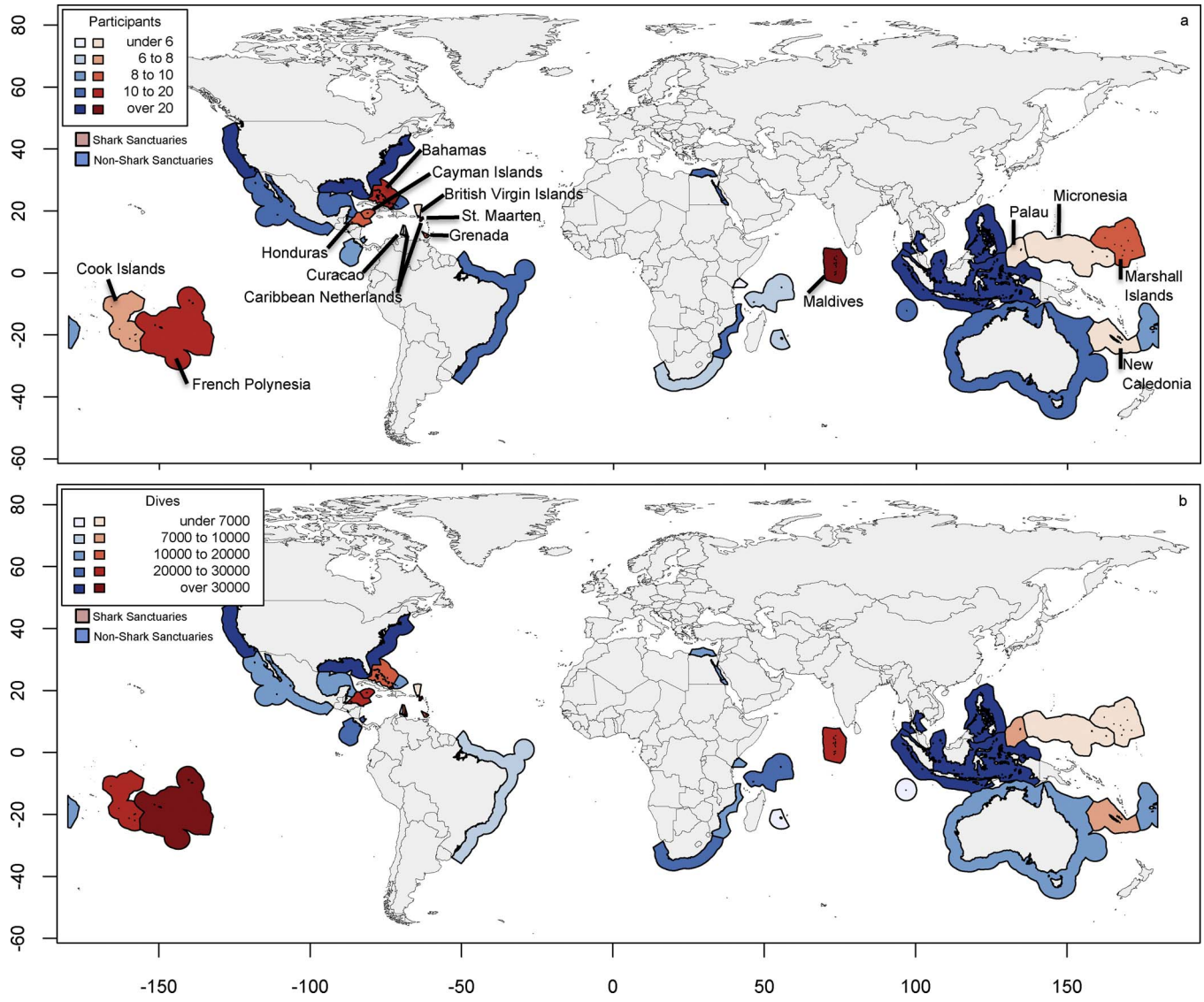

Fig. 1. Diver observation effort by country. Effort in number of participants (a) and number of dives (b) in shark sanctuaries (red) and non-shark sanctuaries (blue). Note: Since the time of writing, Curaçao and Grenada appear to have delayed implementing shark sanctuary laws, and Kirbati has moved to implement shark sanctuary laws. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

of the animals", but the possession of imported sharks or shark parts is not explicitly prohibited; however, bycatch, an important source of shark mortality (Oliver et al., 2015; Worm et al., 2013), is treated fairly consistent across all regulations where all caught sharks are required to be returned to sea regardless of being dead or alive (See additional information and details of shark sanctuary legislation in Ward-Paige, 2017).

Sanctuaries that aim to protect all shark species of all age classes, should, in theory, promote population protection and recovery. However, the success of a sanctuary in rebuilding shark populations may be complicated by the catch of sharks that travel outside of the sanctuaries, by illegal catch or bycatch inside the sanctuary (Chapman et al., 2013; Davidson, 2012), and by other threats such as marine debris, or the degradation of essential habitat like nurseries. The effectiveness of shark sanctuaries has also been questioned more generally, as they may divert attention from other conservation and fishery management efforts, and because insufficient enforcement could enable further overexploitation (Davidson, 2012; Dulvy, 2013).

Despite these possible barriers, the recent momentum towards implementing shark sanctuaries suggests public and governmental support for this conservation strategy, and hence, a need to evaluate their effectiveness. Yet, for most shark sanctuaries there is a lack of baseline data that can be used to evaluate the success of the sanctuary in protecting and rebuilding shark populations. Compounding this is the fact that a complete ban on catch and bycatch removes the possibility of fisheries-dependent data collection and monitoring. Therefore, acquiring a fisheries-independent snapshot of shark population status, trends, and human use patterns inside sanctuaries is an important first step in assessing the potential value of shark sanctuaries for conservation.

The thousands of resource users, who regularly explore the marine environment making qualitative observations on a daily basis, present an opportunity for comprehensive data collection (Nadon et al., 2012; Topelko and Dearden, 2005; Ward-Paige and Lotze, 2011). With very few exceptions, the majority of these observations remain undocumented and unused. However, when observations are collated and standardized, they can be used to define important biological trends and human use patterns; this has been shown repeatedly in particular for recreational divers (Nadon et al., 2012; Topelko and Dearden, 2005; Ward-Paige et al., 2013, 2010a,b; Ward-Paige and Lotze, 2011). Here we report results from a diver-based 'Global Marine Conservation Assessment' survey, via the eOceans.org platform, that was conducted in