Behavioural impact of marine protected areas in international waters

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Abstract

The world's largest Marine Protected Area (MPA) has been established in international waters of Ross Sea region in Antarctica to protect the world's most pristine ecosystems. Although some evaluations of national protected areas have been provided on fisheries, there has been limited work understanding the effect on fishing behaviour, especially in the protected areas beyond national jurisdiction. Using a high-resolution vessel tracking dataset and two quasi-experimental designs (regression discontinuity and ex-post analysis), the research examined the causal effects of an MPA in international waters on fishing behaviour. We found a significant discontinuity effect in fishing behaviours around the geographical boundary of the protected areas. We also found that MPA-affected fishers spent less time fishing as a direct consequence of losing an important fishing ground, and more time sailing as they sought alternative grounds. Overall, our research provides empirical evidence that MPAs in international waters can be effective in deterring fishing activities, but adjacent fishers may face increased fishing costs.

Key Words

Marine Protected Area, High Sea, Fisher behaviour, Quasi-experiments, Southern Ocean

1. Introduction

Marine protected areas (MPAs) are established to protect marine ecosystems and biodiversity by delineating regions with resource use limitations. While 33% of marine fish stocks in the international waters are over-exploited (FAO, 2018), only less than 2% of the high seas are under protection (Brooks et al., 2020; WDPA, 2021). As open access resources, establishing MPAs in international waters is subject to the difficulties in addressing multiple and conflicting uses (O'Leary et al., 2012). The monitoring and management of MPAs beyond the jurisdiction of any country are more difficult in nature. Resource users neither have incentive to be responsible for its sustainable development nor to be effectively regulated by the governments (Klain et al. 2014; Huang & Smith, 2014). Therefore, creating MPAs in high seas is a challenging work and requires the international cooperation of relevant stakeholders.

Fisher behaviour was emerging as an important contextual subject of marine protection policies (Bennett, 2019), which provides a lens on patterns of benefits in MPAs, changes in fishing pressure within the protected areas, and the effectiveness of conservation rules (Branch et al., 2006; Fulton et al., 2011; Yamazaki & Kiyama, 2018; Andrews et al., 2021). Therefore, understanding the behavioural response of fishers is essential to convince stakeholders that high seas MPAs can deliver the desirable outcomes. Previous studies have suggested three potential concerns, including illegal fishing across the borderlines (Charles & Wilson, 2009), fishing-the-lines (i.e., fishing efforts may spill-over from MPAs to the surrounding unprotected waters and concentrate at the boundaries of the protected areas) and remote spill over of fishing efforts to alternative fishing grounds (García-Rubies et al., 2013).

Disentangling the causal effects of MPAs on fisher behaviour is a challenging task. Human behaviours coupled with protected areas are dynamic and interconnected with feedback across social and environmental dimensions (Liu et al., 2007; Halpern et al., 2008). Such reverse feedback between environmental and human elements results in challenges for causal inference. However, recent studies found that less than 10% of the studies which evaluate the impact of MPAs have successfully characterised the sources of spatial and temporal variation in policy intervention assignment (Ferraro et al., 2011; Lynham et al., 2020).

This paper aims to provide causal evaluation on fishers' behavioural responses to MPAs in international water by using the case of the Ross Sea Marine Protected Area (RSMPA). We used the vessel tracking data inferred from the automatic identification system (AIS) based on 0.1 degrees grids resolution from 2012 to 2019. In our analysis, we first performed a regression discontinuity (RD) design to analyse the RSMPA's effect on adjacent fishing efforts. Since fishing vessels within 50 kilometres of the RSMPA's boundaries face identical fishing conditions on either side (Englander, 2019), we can test the causal effect of the protected areas on fisher behaviour by evaluating the difference in fishing efforts just inside RSMPA compared to just outside. The RD experiment was purposed to test the deterrence and potential fishing-the-lines effect in RSMPA's adjacent waters. Second, using fishers in Antarctic Peninsula as a control group, we performed an *ex-post* analysis to estimate the causal impact of the RSMPA on fishers' time allocation on fishing and sailing during the trip. This analysis attempted to provide empirical evidence on cost of MPAs from the perspective of fishers.