



BREN SCHOOL OF ENVIRONMENTAL SCIENCE & MANAGEMENT

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Dear Editors of Science,

On behalf of my coauthors Christopher Costello and John Lynham, I am pleased to submit our manuscript "Well-Designed Fishery Markets Enable Large-Scale Marine Conservation" for consideration as a Report in *Science*.

International goals aim to protect 10% of the oceans by 2020, and 30% by 2030. To meet these targets, large swaths of ocean (often 50% or more of a country's EEZ) will have to be closed to fishing, potentially leading to large losses in fishery revenue. Why would a country willingly commit to such conservation? We show that cross-country fishery markets can be designed (if newly implemented) or modified (if they already exist) to promote, rather than penalize, large-scale conservation.

We do this through a combination of spatial bioeconomic modeling and empirical analysis of large-scale closures in the Pacific using vessel-level tracking before, and after, closures. The model allows us to simulate different market designs and shows how successful implementation of large-scale Marine Protected Areas under effort markets depends on two key features: tradable fishing rights across countries and the rule for allocating rights across countries. Tradable fishing rights allow a country to capture the benefits of conservation by selling harvest rights to other countries; this dramatically reduces the cost of conservation. Allocating rights based on stock location, rather than previous fishing effort, ensures that a country is not penalized in the future for engaging in large scale conservation.

We then test the model with data from Phoenix Islands Protected Area (PIPA) one of the world's largest Marine Protected Areas, implemented in 2015 by Kiribati. We continuously track position and activity of 313 tuna purse seiners operating in the region between 2012 and 2018 and quantify time spent in Kiribati and other countries' waters, effort redistribution, and behavioral changes before and after the implementation of PIPA. Consistent with the model's predictions, we find that fishing vessels that previous had fished in PIPA largely moved outside of Kiribati, but that because fishing rights were transferable across countries, the cost of conservation to Kiribati were substantially reduced. This is an important lesson for other Pacific Island nations currently considering large scale marine conservation.

Our research is of particular interest to managers, policy makers, conservation scientists, and economists. Target 11 of the Convention on Biological Diversity (signed by 150 government leaders) aims to protect 10% of the oceans by 2020, and The Global Deal for Nature calls for 30% protection by 2030. Today, less than 3% of our oceans are within fully-protected areas. If nations are to meet these ambitious goals, sudden large-scale conservation will be needed. Our work shows how the design of fisheries markets can incentivize large-scale conservation to the implementing countries.

All authors contributed equally and accept responsibility for this work. The manuscript has not been published elsewhere and is not under consideration by another journal. We have no conflicts of interest. Our raw and processed data and code are available at our online GitHub repository. Five suggested referees with expertise in fisheries, marine conservation, and property rights include: Jane Lubchenco, Enric Sala, Ana Parma, Jeremy Collie, and Kailin Kroetz.

Thank you for your consideration. We look forward to hearing from you.
Sincerely,

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