

## Fish banks: An economic model to scale marine conservation



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### ABSTRACT

Only 2.1% of the ocean is in actively managed marine protected areas (MPAs). Achieving the United Nations' target of 10% of the ocean protected by 2020 will require an aggressively implemented mix of large MPAs in remote areas, and small MPAs in inhabited coastal areas. Replication of small no-take MPAs (marine reserves) in coastal areas at the global scale is more likely to occur if reserves are designed as investment opportunities – ‘fish banks’ that produce new profits based on ecosystem services such as tourism and fish production. Here a pro forma business plan for a marine reserve using private investment and local management is presented. Total annual profit before the reserve was €254,000 (from fishing only); in year 8 after creation of the reserve, profit (fishing + tourism) was €3.3 million. Given the right conditions, the net present value of the reserve can be between 4 and 12 times greater than the no-reserve counterfactual. In our model, (1) the tourism sector covers the costs of creation and operation of the reserve as an investment in a profitable business; and (2) fishers become shareholders and receive income from tourist access fees; their profits increase as soon as one year after the creation of the reserve. A series of financing mechanisms to create and manage fish banks is also proposed. If designed properly, fish banks can help restore marine biodiversity and ecosystem services, and can create jobs, help fishers, and bring in significantly greater economic profits than the absence of protection.

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### 1. Introduction

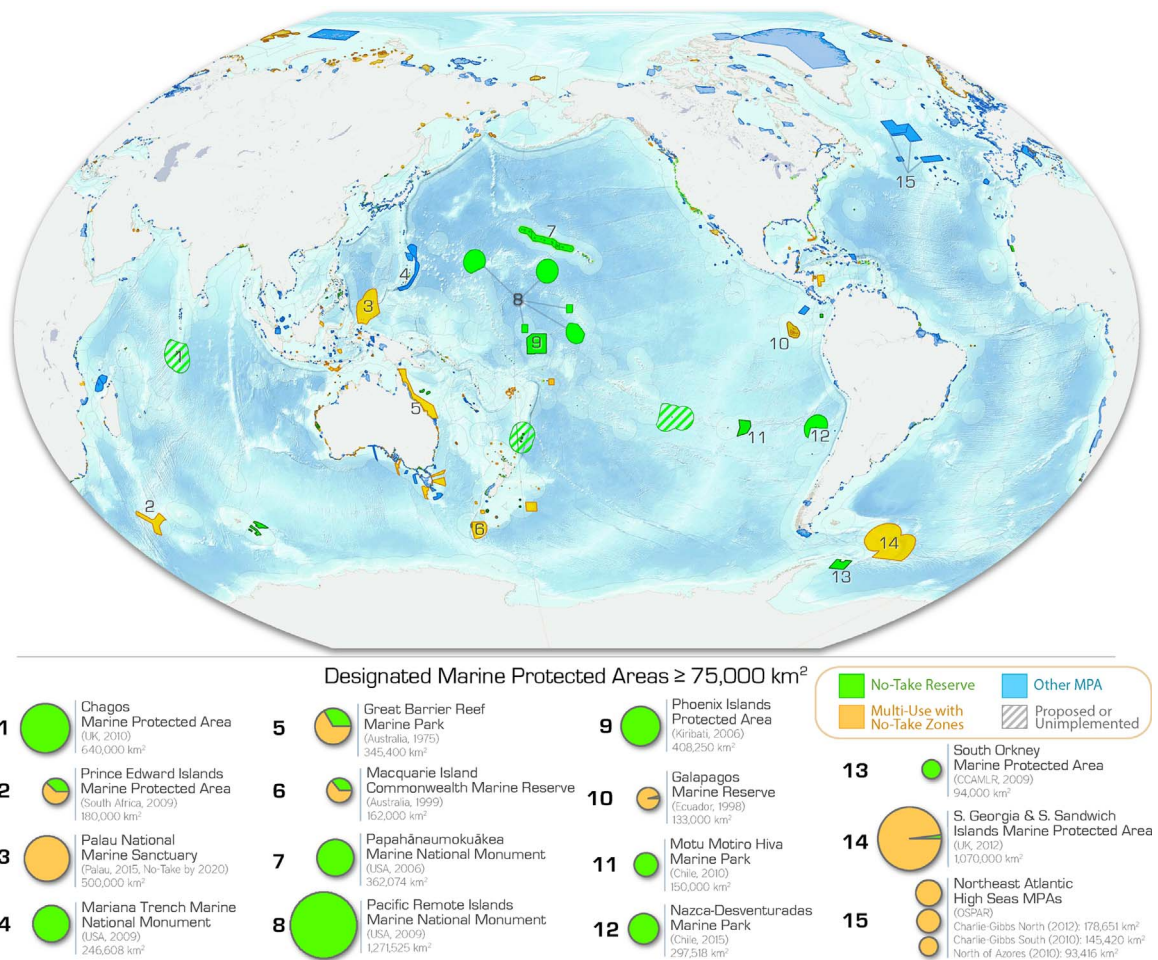
While 14% of earth's land surface is protected from extractive use, only 2.1% of the ocean is in actively managed Marine Protected Areas (MPAs) (Fig. 1). Declines in many of the world's fisheries, combined with threats from invasive species, pollution, and ocean acidification recently led the parties of the UN Convention on Biological Diversity (CBD) to set a target of 10% of marine and coastal areas protected by 2020 (Aichi Biodiversity Target 11 [1]). How will this ambitious target be met? It could likely be achieved through a combination of tens of thousands of small marine

protected areas (MPAs) in inhabited areas, and a smaller number of very large MPAs (100,000 s km<sup>2</sup> each) in remote places. Creation of very large no-take marine reserves such as Chile's Nazca-Desventuradas Marine Park and the U.S. Pacific Remote Islands Marine National Monument will boost the percentage of the ocean protected. However, there is no commonly-adopted formula for replicating small-scale, locally-endorsed marine reserve successes to the global scale. Here a business approach whereby marine reserves can be created and managed locally through private investment is proposed. This approach will rely heavily on no-take marine reserves, which have shown the biggest ecological and economic benefits caused by the restoration of ecosystem services [2,3] (in addition to partially-protected MPAs).

No-take marine reserves can act like financial investments with a principal set aside that produces interest, if they are well

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**Fig. 1.** The marine protected areas (MPAs) of the world: partially-protected MPAs (orange areas), no-take marine reserves (green), and other protected areas (e.g., protected on paper but with insufficient legislation or enforcement; blue). Currently 2.1% of the ocean is in marine protected areas *sensu lato*, and only 1% of the ocean is in no-take marine reserves (mpatlas.org). The 15 largest MPAs that have been implemented are highlighted. It would take 17,600 more average-sized MPAs to achieve the UN Convention on Biological Diversity target of 10% of the ocean protected by 2020. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

designed and managed. Marine reserves result in an average increase of 446% in fish biomass within a decade, relative to un-protected areas nearby [2]; the restoration of ecosystem services such as fish production (through spillover of fish and invertebrates) that can benefit the adjacent fishing industry [4,5]; and increased biodiversity that can attract more tourism, producing up to 36 times more revenue than fishing [6]. In addition, the protection of coastal ecosystems preserves important ecosystem services such as efficient carbon sequestration [7], coastal protection from storms [8], and replenishment of local fisheries [9].

Why have these bright spots not been replicated globally? The main reasons are lack of awareness among stakeholders, inappropriate governance, and unsustainable funding models. Because protection often results in short-run losses and fishers lack secure and exclusive access to the spillover from marine reserves (which are a local public good in economic terminology), fishers rationally choose the status quo over the prospect of better fishing opportunities and livelihoods within a few years.

By coupling institutional reform and private investment, marine reserves could be seen as ‘fish banks’ – an investment in future prosperity rather than a foregone economic opportunity. Empirical data show that the economic benefits of reserves can offset the costs of closure in as little as five years, in some cases doubling the income of local fishers [4]. An important consideration for any form of private investment involves securing the benefits of

protection by providing exclusive access to local fishers, businesses, or communities [10]. Establishing these access rights ensures that a community benefits from its own conservation actions, thus securing a platform for investment by other actors. Here a pro forma business plan is developed to show how to implement fish banks and capitalize on the ecosystem services they provide, and describe some financing mechanisms to create and manage fish banks.

## 2. Material and methods

The creation of a marine reserve was modeled, exclusively with private investment, and managed by a local entity of shareholders (fishers and tourist operators), using empirical data from the Medes Islands (see below). For simplicity our model considers only ‘ecotourists’ who visit the reserve to dive, snorkel, and/or tour the reserve on glass bottom boats, as the new source of revenue (though fishing remains a revenue source). In our model, all ecotourists pay a reserve access fee (as opposed to only scuba divers currently); fishermen receive a percentage of these access fees as compensation for foregoing a fraction of their traditional fishing grounds; and the tourism industry covers the establishment of the reserve and part of its management costs, since they are likely to be the ones to benefit the most economically. Tourist activity

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