COMMENTARY

Averting a global fisheries disaster

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Oceans cover 71% of Earth's surface and support an estimated 3 billion people with food and vital micronutrients (1). Consequently, the fate of the ocean and its living resources is a first-order question in ecology and environmental science (2). In this context, a 2006 panel of ecologists and fisheries scientists empirically charted the consequences of an ongoing depletion of marine biodiversity, such as declining fisheries, reduced water quality, loss of habitat, and less resilient ecosystems (3). The paper became widely known, however, for a scenario of global fisheries collapse derived from extrapolating catch trends to the year 2048. This projection served as a flash point in the ongoing discussion about the sustainability of global fisheries, or lack thereof (4). A polarized debate ensued, which was productively addressed by a subsequent panel that highlighted solutions for rebuilding depleted fisheries, where appropriate governance structures exist (5). That work, however, along with several follow-up papers (6–8), did not revisit the original projections. A new paper in PNAS (9) now uses updated methodology and an innovative combination of available data on catch trends, life history, and stock assessments to revisit the prospect of a global fisheries disaster, and what may be required to avert it.

The analysis of Costello et al. (9) confirms that the average state of global fish stocks is poor and declining. Of 4,714 fisheries assessed in the year 2012, only 32% remained at or above the biomass target that supports maximum sustainable yield (B_{MSY}), whereas 68% have slipped below that critical threshold. This compares to 63% of assessed stocks tracking below B_{MSY} in 2006 (5). Even more concerning is the finding that only 35% of stocks are currently fished at a level that would allow for recovery toward the B_{MSY} target. This means that most overfished stocks will experience further depletion, despite their compromised status. An astounding 118 fisheries were mismanaged at mortality rates more than 10-fold the sustainable target, and 3 had greater than 100-fold higher mortality. If fish stocks were financial assets, most would indeed represent a poor choice for investors.

Feeding these data into a simple bioeconomic model unsurprisingly reveals further depletion and collapse of stocks under a business-as-usual scenario (Fig. 1). The authors calculate that, under current management, 88% of stocks would be overfished and well below their target biomass in 2050. For comparison, the Food and Agriculture Organization of the United Nations estimates that 29% of assessed major stocks currently are overexploited or depleted (1). Without a doubt, global fisheries are in for a hard landing if nothing changes. This is especially sobering as several of the authors reporting in PNAS today have previously championed a decidedly more optimistic outlook (4). At the same time, these findings sharpen our focus on much-needed solutions.

In addition to business as usual, the authors ran two other model scenarios, both assuming instantaneous global management intervention (Fig. 1). The first scenario assumes that all fisheries will be exploited at a rate that is predicted to sustain long-term maximum sustainable yield (MSY). In other words, management is being optimized for maximum catch, whatever the cost may be. This is close to current policy mandates, as enshrined for example in the United Nations Convention on the Law of the Sea. This strategy is projected here to result in slow recovery, such that 85% of stocks are approaching B_{MSY} in 2050. Essentially, this would reverse the proportion of overfished versus healthy stocks compared with business as usual. Even more striking, a scenario that is geared to optimize long-term profits (as opposed to yield) may produce even better outcomes, with 97% of stocks within reach of the biomass threshold B_{MSY} by 2050. Total biomass summed across all stocks would more than double, and profits would more than triple compared with business as usual (Fig. 1). Clearly, current management practices are not just hurting biodiversity and our food supply; they also make poor economic sense. This is particularly visible in countries where overfishing has been more pronounced, such as China, Indonesia, and India: the study shows that these countries have most to gain from comprehensive fisheries reform, both in terms of food security and economic advantage.

So how do we get from here to there? Overfishing is an interesting problem in that the solution is

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See companion article on page 5125.

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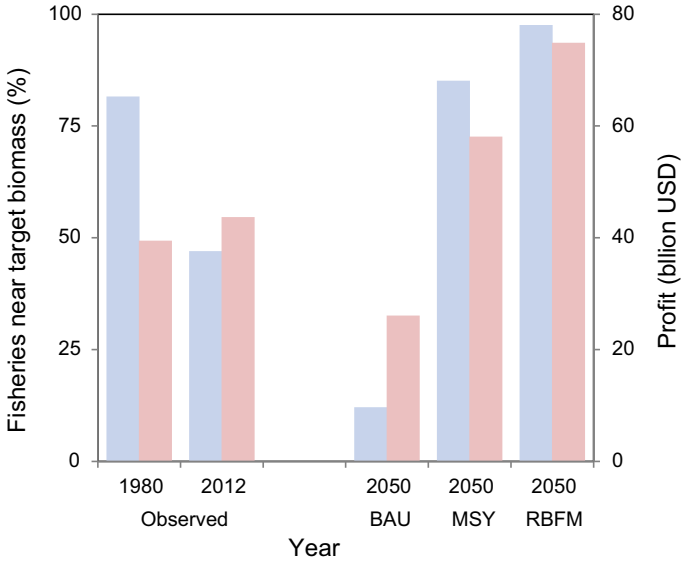

Fig. 1. Fisheries at a global crossroads. Although many fish stocks, such as tropical skipjack tuna (*Left*), continue to generate food and income, an increasing number is being depleted below target levels such that their productivity will be compromised (*Right*). Shown are data from 1980 and 2012 depicting the percentage of 4,714 fisheries assessed by Costello et al. (9) that remain close to target biomass (blue bars) and generate profits (red bars). Future scenarios for 2050 depict aggregate fishery status and profit under business as usual (BAU), management for maximum sustainable yield through catch limits (MSY), and management for maximum profit through rights-based fisheries management (RBFM). Image (*Left*) courtesy of Marine Photobank/Alex Hofford.

conceptually simple and universal: we need to kill fewer fish. In practice, however, biological, environmental, and socioeconomic idiosyncrasies often defy a one-size-fits-all solution. Costello et al. (9) endorse rights-based fisheries management (RBFM) as the best solution to achieve more rational management of fisheries. This approach addresses the highly competitive open-access nature of many fisheries, which incentivizes overfishing because individual fishers are not guaranteed to see the benefits of leaving fish in the water. RBFM seeks to change this by providing individual or communal access rights, or "catch shares," that are akin to owning shares in a publically traded company. In theory, this incentivizes rebuilding of depleted resources because a larger stock makes a given share more valuable and pays greater dividends. In practice, however, the empirical support for successful RBFM is mixed, and varies substantially by region (10). In contrast to the model scenarios of Costello et al. (9), empirical metaanalyses found no effect, on average, of RBFM implementation on population biomass (11, 12). Likewise, a review of 10 regions where rebuilding of depleted stocks was at least partially achieved revealed RBFM as only one out of many tools necessary to reform fisheries (5). Gear restrictions, protected areas, and reductions in fishing capacity and total allowable catch were used in most cases, whereas catch shares played a role in only one-half of the regions (5). This does not mean that RBFM is ineffective, but that it needs to be complemented by other solutions. This is akin to solving climate change by a series of interlocking "stabilization wedges" (13), rather than by any one policy or technology.

By emphasizing policies that maximize profits or total catch, however, the authors perpetuate a management scheme that is heavily skewed toward the "top earners" (14). Although this may reflect current economic thinking, it needs to be broadened to a more encompassing strategy that recognizes conservation benefits of currently unproductive or unprofitable stocks. Importantly, careful analysis has shown that the full biodiversity of stocks is crucial for long-term stability of economic benefits and yield (3, 15, 16) as it provides a portfolio of responses to ongoing environmental change, which is already compromising previously productive "blue chip" stocks (17, 18). In other words, taking care of the losers as well as the winners will ensure that we can still feed ourselves from the sea in the future.

In conclusion, the analysis of Costello et al. (9) shows that the future of fisheries is tenuous, unless comprehensive fisheries reform becomes a unifying focus for global fisheries management. Importantly, global rebuilding already is an international management target under the Convention on Biological Diversity (19), and individual countries have made efforts to curb fishing pressure, reduce harmful subsidies, and eliminate overcapacity (5). Unfortunately, such efforts have sometimes displaced fishing pressure to developing countries and the high seas (5, 6), where the "dark side" of illegal, unregulated, and unreported catches still looms large today (2). Among other innovations, recent advances in satellite monitoring of fishing vessels offer hope that such damaging practices could soon be abolished (20). On the political front, the United Nations is working toward a new Implementation Agreement to better protect biodiversity, vital food resources, and natural capital on the high seas. Without a doubt, much can and will be done to avert a worldwide fisheries disaster, with the results of Costello et al. (9) providing a timely warning to implement necessary reforms at a global scale.

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