Conservation Biology

Diversity

Need to address gaps in global fisheries observation

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Introduction

Military technologies accelerated the ability to navigate and find fish, leading to widespread overfishing and some rapid stock declines (Pauly et al. 2002). These technologies evolved into radar-based systems that enable near real-time observation of fishing vessels. Harvest rates increased dramatically with these technologies, but lack of basic monitoring and surveillance remains a major problem for global fisheries management (Beddington et al. 2007; Anticamara et al. 2011). Much knowledge of global fishing effort is still derived from handwritten logbooks. Vessels equipped with transponders can hide their location or purpose, and prosecution success for most fishing misdemeanors is very low (Gross 2018). Consequently, illegal, unreported, and unregulated (IUU) fishing has hindered effective management of marine ecosystems, while one-third of assessed marine fish stocks are fished at biologically unsustainable levels (FAO 2016) and many more unassessed species and stocks are almost certainly overharvested (Pitcher & Cheung 2013).

Information on maritime activity is freely available or can be purchased from data vendors (e.g., MarineTraffic and Global Fishing Watch). Most providers harvest information transmitted from vessels' automatic identification systems (AISs) or vessel monitoring systems (VMSs). Despite limitations of data derived from these systems, there are near real-time databases of fishing effort that provide opportunities to combat IUU fishing, better understand where and what fleets need management attention, illuminate key drivers of fishing behaviors, and identify overlap with marine resources and vulnerable species (Cabral et al. 2018; Kroodsma et al. 2018). But not all countries require transponders, especially for small vessels; therefore, even with these advances much of the world's fishing remains undetected.

Information Gaps

Gillnets (anchored or drifting) often generate high bycatch rates, particularly for vulnerable megafauna (e.g., marine mammals) (Lewison et al. 2004). Gillnets are simple and relatively cheap to operate and, thus, commonly used in coastal waters around the world, particularly in developing countries (Northridge et al. 2017).

Tuna gillnet fisheries in the Indian Ocean have expanded since 2003. Nations, such as Iran, India, and Sri Lanka, each operate thousands of boats (Aranda 2017). Large-scale illegal gillnetting is rampant, despite a 1992 UN Resolution banning drift gillnets over 2.5 km in international waters (Ardill et al. 2013). There are multiple reports of illegal high-seas gillnet fishing by Chinese longline vessels (Cutlip 2016), and Pakistani gillnetters reportedly set 26-km-long nets in the high seas (Moazzam 2012).

Equally problematic are legal but unmonitored fisheries. Indian Ocean countries must submit catch and effort data by cell degree for purse seines and longlines for their industrial tuna sectors to the Indian Ocean Tuna Commission (IOTC), whereas no spatial information is required for gillnet vessels, which rarely have logbooks, observers, or AIS (Ardill et al. 2013). Gillnets are absent from open-source satellite maps because most of the >60,000 estimated vessels are considered artisanal or coastal, even though some are as large and fish the same areas as the industrial vessels (Aranda 2017).

Monitoring and Surveillance

Inconsistent monitoring of fisheries at national and regional scales threatens food security and marine biodiversity. Missing catch and effort information leads

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to an inaccurate understanding of stock status and likely contributes to unsustainable catch allowances and stock collapses (Beddington et al. 2007). Effective monitoring of fishing effort and surveillance of vessel compliance leads to better-managed fisheries that are more profitable over the long term (Sumaila et al. 2012; Pons et al. 2017). Indonesia recently reported a decrease in illegal fishing activity and increased profits for fishers after a multifaceted initiative, which included publicizing their VMS information to improve transparency, monitoring, and enforcement (Cabral et al. 2018). Better management of target stocks also has important spillover benefits for bycatch species (Burgess et al. 2018).

Taking Responsibility

The International Maritime Organization mandates AIS on large vessels, and regional fisheries management organizations, such as the IOTC, have requested better monitoring data from their member countries, but these standards must be implemented at the national level. It is, therefore, essential that developing nations receive financial and technical support and developed nations show leadership by strictly enforcing standards. This must be seen not as a sunken cost but as better prioritization of budgets to improve management and longer-term stock viability. For instance, implementing some basic monitoring and surveillance costs less than subsidizing unprofitable fisheries. Global high-seas fishing fleets received $4.2 billion in government subsidies in 2014, far exceeding the estimated $1.4 billion net economic benefit of those fisheries (Sala et al. 2018). The largest subsidies are given by governments of developed countries (Japan, China, European Union), but many of these countries are underperforming in their monitoring and surveillance, especially of distant-water fleets (Bellmann et al. 2016; Sumaila et al. 2016; Tickler et al. 2018).

Developing countries face more obstacles in balancing food provision and economic needs with marine biodiversity and ecosystem health. At the extreme is Yemen, which is believed to have several thousand gillnetters without transponders and, understandably, is yet to submit a report to the IOTC (Allison et al. 2009; Moreno & Herrera 2013). India is much more developed but also faces depleted coastal fisheries. In response, the government promoted the growth and mechanization of offshore and deep-water fleets with subsidies for engines and fish finders (Bhat & Bhatta 2006). India now ranks seventh in global seafood exports (FAO 2018), operates the region's second largest tuna gillnet sector after Iran (Aranda 2017), and is the ninth largest subsidizer among developing nations, providing approximately half a billion (U.S. $) in subsidies in 2009, mostly to enhance fishing capacity (Sumaila et al. 2016). The government has not provided for adequate monitoring of fleet expansion, even though AIS also provides safety benefits (its original purpose) such as preventing ship collisions.

Effective monitoring requires more than a few pieces of electronics and software. The government must have the infrastructure to manage the data, analyze the outputs, and respond with appropriate enforcement actions. Assuming better surveillance is necessary for successful management in the long term, investing in monitoring and surveillance is a better choice than expanding fishing capacity. However, long-term visions are supplanted by shorter-term livelihood needs unless there is a political will to improve fishing practices and tangible rewards for greater transparency (e.g., higher-value seafood products). Thus, the responsibility for improvement of fisheries monitoring also lies with seafood corporations and consuming nations. In 2012, 13 corporations controlled about 40% of the catch of the world's largest and most valuable stocks (Osterblom et al. 2015), and Japan, the United States, China, and the European Union account for over two-thirds of global seafood imports (FAO 2018). Governments of fishing countries are often shamed for their poor practices, but less public attention has focused on consumer nations or the corporations directly responsible for fishing. Concerted efforts have forced the Thai government to invest in better fisheries governance and Thai Union, one of the world's largest seafood producers, to commit to better practices (Lewis & Boyle 2017). Another example is U.S. legislation requiring imported seafood to meet stricter management standards (Williams et al. 2016). Public awareness of seafood sustainability has increased but more direct action is needed, and costs of these actions must be spread more equitably across the participators and beneficiaries of marine fisheries.

The necessary restructuring of the seafood supply chain is daunting, and monitoring and surveillance are only 2 pieces of the puzzle. However, they are essential because making marine activities more visible makes them more governable (Toonen & Bush 2018). Because information on fishing activity and especially fishing locations is kept tightly guarded by management agencies and by vessel owners, stronger leadership from major nongovernmental organizations, UN Food and Agriculture Organisation, regional management bodies, and seafood consumers is necessary to allow for improved monitoring and surveillance.

Future Science Needs

Without demonizing developing countries or unfairly assigning blame, technological advances should be used to determine which fisheries are underperforming in monitoring and surveillance and the reasons behind this underperformance. The status of global fisheries is too urgent to continue ad hoc monitoring and surveillance, which keeps less profitable or less visible sectors (e.g.,

tuna drift gillnets) free of real regulatory or commercial pressure to improve. Targeting gillnet sectors in places such as India, is an opportunity for gains, while countries such as Yemen, require immediate and more extensive financial assistance. Although the need is particularly urgent in unobserved fisheries in developing countries, all parties to the global fishing fleet must be pressured to make smart investments and honest commitments to improve seafood sustainability.

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Literature Cited

Allison EH, et al. 2009. Vulnerability of national economies to the impacts of climate change on fisheries. Fish and Fisheries **10:** 173–196.

Anticamara JA, et al. 2011. Global fishing effort (1950-2010): trends, gaps, and implications. Fisheries Research **107:**131–136.

Aranda M. 2017. Description of tuna gillnet capacity and bycatch in the IOTC Convention Area. Report IOTC-2017-WPEB13-18. Indian Ocean Tuna Commission, Rome.

Ardill D, Itano D, Gillett R. 2013. A review of bycatch and discard issues in Indian Ocean tuna fisheries. Smart fish. Report SF/2013/32. Available from http://www.fao.org/fishery/topic/16917/en (accessed July 2017).

Beddington JR, Agnew DJ, Clark CW. 2007. Current problems in the management of marine fisheries. Science **316:**1713–1716.

Bellmann C, Tipping A, Sumaila UR. 2016. Global trade in fish and fishery products: an overview. Marine Policy **69:**181–188.

Bhat MG, Bhatta R. 2006. Mechanization and technical interactions in multi-species Indian fisheries: implications for economic and biological sustainability. Marine Policy **30:**237–248.

Burgess MG, et al. 2018. Protecting marine mammals, turtles, and birds by rebuilding global fisheries. Science **1258:**1255–1258.

Cabral RB, et al. 2018. Rapid and lasting gains from solving illegal fishing. Nature Ecology & Evolution **2:**650–658.

Cutlip K. 2016. Our analyst nets another IUU bust. Global Fishing Watch. Available from http://globalfishingwatch.org/impacts/our-analyst-nets-another-iuu-bust/ (accessed May 2018).

Food and Agriculture Organization of the United Nations (FAO). 2018. Fishery commodities and trade (Fishstat database). FAO, Rome. org/fishery/statistics/global-commodities-production/en (accessed May 2018).

Gross M. 2018. Eyes on our planet. Current Biology **28:**R89–R92.

Kroodsma DA, et al. 2018. Tracking the global footprint of fisheries. Science **359:**904–908.

Lewis SG, Boyle M. 2017. The expanding role of traceability in seafood: tools and key initiatives. Journal of Food Science **82:**A13–A21.

Lewison RL, et al. 2004. Understanding impacts of fisheries bycatch on marine megafauna. Trends in Ecology & Evolution **19:**598–604.

Moazzam M. 2012. Status report on bycatch of tuna gillnet operations in Pakistan. Report IOTC–2012–WPEB08–13. Indian Ocean Tuna Commission, Cape Town.

Moreno G, Herrera M. 2013. Estimation of fishing capacity by tuna fishing fleets in the Indian Ocean. Report IOTC–2013–SC16–INF04. Indian Ocean Tuna Commission, Victoria, Seychelles.

Northridge S, et al. 2017. Disentangling the causes of protected-species bycatch in gillnet fisheries. Conservation Biology **31:** 686–695.

Osterblom H, et al. 2015. Transnational corporations as "keystone actors" in marine ecosystems. PLOS ONE **10** (e0127533) https://doi.org/10.1371/journal.pone.0127533.

Pauly D, et al. 2002. Towards sustainability in world fisheries. Nature **418:**689–695.

Pitcher TJ, Cheung WWL. 2013. Fisheries: Hope or despair? Marine Pollution Bulletin **74:**506–516.

Pons M, et al. 2017. Effects of biological, economic and management factors on tuna and billfish stock status. Fish and Fisheries **18:**1–21.

Sala E, et al. 2018. Assessing real progress towards effective ocean protection. Marine Policy **91:**11–13.

Sumaila UR, et al. 2012. Benefits of rebuilding global marine fisheries outweigh costs. PLOS ONE **7** (e40542) https://doi.org/10.1371/journal.pone.0040542.

Sumaila UR, et al. 2016. Global fisheries subsidies: an updated estimate. Marine Policy **69:**189–193.

Tickler D, et al. 2018. Far from home: distance patterns of global fishing fleets. Science Advances **4:**4–10.

Toonen HM, Bush SR. 2018. The digital frontiers of fisheries governance: fish attraction devices, drones and satellites. Journal of Environmental Policy and Planning https://doi.org/10.1080/1523908X.2018.1461084.

UN Food and Agriculture Organisation (FAO). 2016. The state of world fisheries and aquaculture 2016. FAO, Rome.

Williams BR, et al. 2016. Marine mammal protections require increased global capacity. Science **354:**1372.