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Bright spots of sustainable shark fishing

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Sharks, rays and chimeras (class Chondrichthyes; herein 'sharks') today face possibly the largest crisis of their 420 million year history. Tens of millions of sharks are caught and traded internationally each year, many populations are overfished to the point where global catch peaked in 2003, and a quarter of species have an elevated risk of extinction [1–3]. To some, the solution is to simply stop taking them from our oceans, or prohibit carriage, sale or trade in shark fins [4]. Approaches such as bans and alternative livelihoods for fishers (e.g. ecotourism) may play some role in controlling fishing mortality but will not solve this crisis because sharks are mostly taken as incidental catch and play an important role in food security [5–7]. Here, we show that moving to sustainable fishing is a feasible solution. In fact, approximately 9% of the current global catch of sharks, from at least 33 species with a wide range of life histories, is biologically sustainable, although not necessarily sufficiently managed.

Stock assessments were available for a total of 65 populations (Supplemental information). A subset of 39 populations (of 33 species) met criteria for biological sustainability, including 27 (of 22) sharks, nine (of nine) rays, and three (of two) chimeras, representing a very small fraction (~2.6%) of global shark diversity (n = 1,188). Of the populations that met biological sustainability criteria, eight populations of five species did not have science-based management plans. Stocks that met some or all of the sustainability criteria mostly occur in the Exclusive Economic Zones (EEZs) of developed countries that have well-developed fisheries management systems (e.g. USA, Australia, New Zealand and Canada; Figure 1). However, there are some developed nations with good fisheries management capacity (e.g. European Union) that have not yet translated this into sustainable outcomes for shark populations.

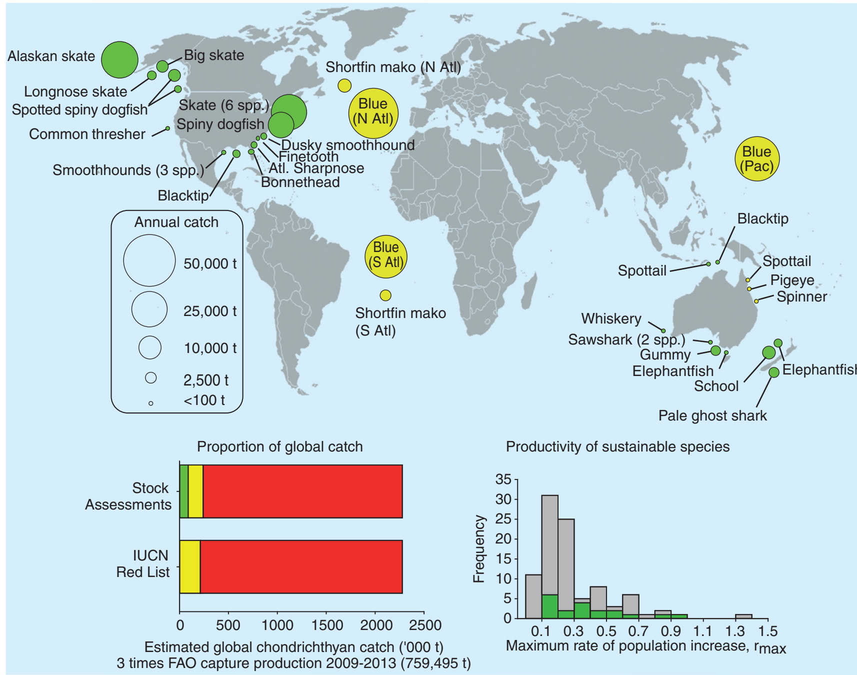

Figure 1. Location and magnitude of sustainable shark, ray and chimaera catches.
Top panel: Location of sustainable and managed (green circles) and sustainable but not managed (yellow circles) shark, ray and chimera populations. Populations assessed as unsustainable or lacking evidence of sustainability (Supplemental information) are not shown. Sustainability is defined as current biomass being greater than that required to achieve Maximum Sustainable Yield ($B_{current} > B_{MSY}$), or current fishing mortality being less than that which will yield MSY ($F_{current} < F_{MSY}$) if current biomass is not available. Managed stocks were those with a science-based management plan in place. Bottom left panel: Proportion of estimated global catch that is sustainable and managed (green), sustainable but not managed (yellow) and lacking evidence for sustainability (red) based on stock assessments and assuming species IUCN-listed as Least Concern and Near Threatened are sustainable but not managed. Bottom right panel: Maximum rate of population increase (r_{max}) of 19 sustainably fished species (green) compared to all other available estimates (n = 75; grey).

The total annual landed catch of the biologically sustainable populations was approximately 204,945 tonnes live weight, approximately 27.0% of the average annual catch of sharks, rays and chimeras reported to the United Nations Food and Agriculture Organization (FAO) over the past five years (2009–2013) of 759,495 tonnes [7]. However, this figure drops to 12.0% (91,460 t) for populations that are both biologically sustainable and have a science-based management plan in place. FAO capture production statistics underestimate true global take of sharks by a factor of 3 or 4 [1]; hence the proportion of biologically sustainable take is closer to 9 %, and 4% of global shark catch is managed for sustainability (Figure 1).

An alternative method of estimating the current annual catch of sharks that is biologically sustainable is to sum the FAO capture production figures for species that are categorized as 'Least Concern' or 'Near Threatened' on the IUCN Red List of Threatened Species. Assuming these species meet the biological sustainability criterion, the average FAO capture production over the last five years of Least Concern and Near Threatened species was 212,691 t (~28% of FAO capture production; Figure 1). Again rescaling to account for underreporting of FAO capture production, this figure reduces to ~7% of total shark catch, similar to the results of stock assessments.

The prevalent view has been that only the most productive species with fast life histories can be managed sustainably [4]. We found that some species with relatively low productivity — with the most common

r_{max} values between 0.1 and 0.2 — can support sustainable fisheries (Figure 1). No species with a maximum rate of population increase ($r_{max} < 0.1$) were identified as sustainable and species capable of achieving sustainability were proportionally more common at $r_{max} > 0.3$. These data suggest that with strong science-based management, most shark species have the potential to support sustainable fisheries.

We highlight five lessons that can help progress sustainability across shark fisheries: first, protect those species with the lowest biological productivity. Sustainable outcomes have been achieved only for species with $r_{max} > 0.1$. Species with very low r_{max} include some deep water species (e.g. gulper sharks) and species with very small litter sizes (e.g. Cownose Ray, Bigeye Thresher Shark) [8].

Second, tuna Regional Fisheries Management Organizations (tRFMOs) should implement precautionary science-based catch limits on the more biologically sustainable high-seas sharks. Some of the largest shark catches come under the remit of tRFMOs. While tRFMOs conduct stock assessments and have some shark-specific rules, they have yet to implement catch limits for blue shark (Atlantic and Pacific Oceans) and shortfin mako shark (Atlantic Ocean) despite repeated scientific advice that catch levels should be capped.

Third, international treaties can contribute to sustainable international fisheries and trade and prompt fisheries management improvements. The Convention on Migratory Species and Convention on International Trade in Endangered Species (CITES) are increasingly being seen as possible drivers of improved shark management [9]. For example, the listing of commercially important shark species on CITES in 2013 and 2016 requires that nations demonstrate that products in international trade do not threaten the survival of the species in the wild. This has required many countries (and tRFMOs) to undertake sustainability assessments (i.e. produce Non-Detriment Findings) and develop product identification and traceability systems that all contribute to improved outcomes for these species.

Fourth, developed countries have a responsibility to support the transition to sustainability in developing countries. Many developed countries import, consume or re-export shark products [6]. Hence, as developed nations bring their fisheries into sustainability and import more fish, they should translate their successes into lessons and capacity building for other nations to ensure that they are able to move towards sustainability.

Finally, responsible, traceable shark fisheries can provide consumers with the ability to choose and purchase sustainable seafood. Traceability has repeatedly and reliably driven sustainability across numerous natural resource supply chains [10]. All products from sustainably caught sharks and rays could be sold as sustainable, including shark fins. At present, the notion of sustainable shark fins is unthinkable to many. Yet, today's sustainable (but not necessarily managed) shark fisheries yield about 4,406 t of dried fins (Supplemental information). This suggests that approximately 8.7% of the fins in the global fin trade are from sustainable sources, but not yet traceable or labeled. Without labeling fins from sustainable sources cannot yet command the price premium that would in-turn feedback to drive sustainability back through supply chains.

Achieving sustainable outcomes for most or all shark populations will require tailored diagnosis and management depending on species and context, rather than simplified solutions such as outright bans. The successes demonstrated here provide a template to guide the expansion of fisheries sustainability. The benefits of such change, for both biodiversity conservation and human food security, argue for tackling the challenge without further delay.

SUPPLEMENTAL INFORMATION

Supplemental Information including experimental procedures and two tables can be found with this article online at http://dx.doi.org/10.1016/j.cub.2016.12.017.

AUTHOR CONTRIBUTIONS

C.A.S. and N.K.D. devised the study, gathered data and wrote the paper.

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