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MARINE CONSERVATION

Fishing boats leave few safe havens for sharks

Global satellite tracking of the oceans has revealed a high degree of spatial overlap between where sharks and industrial fishing vessels are found. This finding underscores the need for shark-conservation efforts.

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Oceans cover 70% of our planet, extending for hundreds of millions of kilometres. Despite their vastness, oceans have not escaped the effects of human activity, and evidence has steadily accumulated in recent decades that disturbances such as overexploitation[1], plastic pollution[2] and climate change[3] have had major negative consequences for marine life. Writing in *Nature*, Queiroz *et al.*[4] add another dimension to this story by showing that vessels fishing on the high seas (the regions of oceans beyond national boundaries) overlap substantially with areas of the ocean that are frequented by sharks, leaving these wide-ranging animals with scant refuge from fishing pressure.

As some of the oceans' fiercest predators, sharks were once presumed to be safe from overfishing[5]. Yet when shark-targeted commercial fisheries were developed in the mid-twentieth century, this presumption was soon proved incorrect. Most of these fisheries underwent a swift cycle of boom and bust, lasting only a decade or so before shark populations plummeted and the fisheries collapsed[6].

The expansion of industrial fishing across the high seas in the latter half of the twentieth century subjected sharks to another threat. Most of those fisheries target tuna and billfish (such as swordfish). These fast-moving fishes have high population growth rates, which allow them to withstand greater fishing pressures than the sharks that are taken alongside them as by-catch (species caught unintentionally) or as secondary targets. Despite the risk of overfishing sharks, regional fisheries-management organizations have been reluctant to develop management plans or catch limits for sharks, and have little incentive to collect data that could be used to demonstrate the negative effects that fishing is having on these species.

However, assessments of available regional data have reinforced concerns about sharks, painting a stark picture of populations that have declined precipitously[7,8]. Sharks, along with their relatives, are now thought to be one of the most threatened groups of marine species, with one-third of them assessed as being at risk of extinction[9]. Nevertheless, the patchy availability of fisheries-dependent data has meant that the full extent to which sharks interact with fishing fleets on the high seas — and the impacts of these fisheries on them — has remained unknown.

Scientists are increasingly using satellite-derived data to fill in such knowledge gaps about the human 'footprint' in the world's oceans. For example, the automatic identification system (AIS) — a locator system used by many boats as a safety feature to prevent collisions — provides data that enable boat movements to be monitored globally. Analyses of AIS data have revealed that fishing-vessel tracks are found across much of the oceans[10].

Queiroz and colleagues paired AIS data with satellite-tracked movements of 1,681 tagged sharks to provide a global estimate of the extent to which areas of the ocean frequented by sharks overlap with active zones of industrial fishing. Focusing on vessels using fishing gear called pelagic longlines, which are responsible for the majority of catches of oceanic sharks globally[11], the authors report that almost one-quarter of the average space that individual sharks move through monthly overlaps with the footprint of these fleets.

White sharks (*Carcharodon carcharias*) and porbeagles (*Lamna nasus*) are listed as being at risk of extinction on the International Union for Conservation of Nature's Red List of Threatened Species. Worryingly, of the shark species studied by the authors, these two had some of the greatest overlap between the areas they prefer and those targeted by the longline fleets. Spatial overlap between the locations of fishing vessels and sharks was also high for commercially valuable shortfin mako (*Isurus oxyrinchus*) and blue (*Prionace glauca*) sharks (Fig. 1).

Underlying the high degree of spatial overlap between sharks and industrial fishing vessels is the mutual targeting of areas of the oceans that attract fish because of their favourable productivity and temperature profiles. Unsurprisingly, congregating in such areas enables both the fishing vessels and the sharks to enhance their catch rates.

More work remains to be done to determine the full extent to which fishing vessels intercept sharks on the high seas. Queiroz and colleagues' study rests almost entirely on data for just 11 shark species, which were tagged and released from a limited number of locations,

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Figure 1 | A blue shark (*Prionace glauca*). Queiroz *et al.*[4] have generated global maps showing the degree of spatial overlap in the oceans between commercial fishing vessels and shark species, which included *P. glauca*.

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and it is estimated that AIS transmitters are fitted on only 50–75% of large fishing vessels. Even with these limitations, the study is a testament to the capacity of modern ecology to provide insights about human impacts on the natural world through the power of collaborative science and big data — more than 150 researchers contributed to collecting or analysing the data from the tagged sharks. Other scientists working in fields facing conservation crises would do well to adopt this type of collaborative approach.

Queiroz and colleagues' study underscores the urgent need for conservation measures to protect large ocean-dwelling sharks. With little to no management measures in place for most of these species, the authors suggest that large-scale marine reserves could help to limit shark exploitation on the high seas.

The idea is a timely one[12,13]. At a United Nations meeting this spring, there were calls to designate 30% of the high seas as marine protected areas, and groups are actively working on site-selection proposals (see go.nature.com/2ohnluq). Nations are in the process of negotiating the first high-seas conservation treaty[14], which will include provisions for establishing protected areas outside the limit of national territories. Such protected areas could provide huge benefits to sharks, especially if the information from Queiroz and colleagues' study is taken into account. However, improvements in fisheries-management measures, including a rise in onboard observers and enforced shark-catch limits, would also be needed to ensure that fishing pressure on sharks outside protected areas is not excessive.

Moving forward, the challenge will be to use the results of this new study to spur effective shark-conservation measures. By illuminating the frequency with which these wide-ranging fishing fleets overlap with sharks, and the hotspots of these interactions, Queiroz *et al.* have provided a much-needed blueprint for conservation actions that could be used to provide sharks with safe havens in our increasingly crowded oceans. ■

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