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Essays and Perspectives

Threats to sharks in a developing country: The need for effective and simple conservation measures

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ABSTRACT

Reductions of shark populations produce negative ecological and economic consequences. Overfishing is the primary threat to these reductions; however, two other indirect problems can be mentioned as threats to sharks populations: shark meat mislabeling, and shark attacks. In this study, we use Brazil as an example to focus on these three critical problems related to shark conservation: the lack of proper, specific identification of landed species in the industrial and artisanal fisheries; shark attacks; and mislabeling in markets. We discuss these situations, highlighting brief examples and conservation barriers. The main goal is to present these problems and provide simple, effective solutions. On the fisheries side, the solution lies in having trained personnel at specific landing ports. Implementation of this practice would also aid in the solution to the mislabeling of shark meat. However, whenever this does not occur, supermarkets or any other final seller should be held legally responsible for the identification. At this stage, genetic techniques such as DNA barcoding must be used. Regarding the shark attack problem, the only truly efficient solution with no indirect effects is education and taking the matter to society, rather than waiting until there is a shark attack incident. The government needs to invest more funds on educational awareness programs and research to avoid encounters with sharks. We must ensure that the society does not see sharks as villains, but instead as key elements in maintaining the ecosystem services that are so valuable to human well-being.

Introduction

Human populations worldwide rely on sharks both directly and indirectly; however, they are generally unaware of this dependence. First, sharks, as apex predators, exert top-down effects by controlling prey populations; therefore, declines in shark populations can lead to cascading effects in ecosystems (e.g., reduction of commercial scallops in northeast Atlantic,

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see Myers *et al.* 2007). Second, shark meat provides much of the protein requirement for poorer communities (WildAid 2007), and many communities depend on small-scale fisheries for subsistence. Third, in some regions shark tourism generates thousands of dollars per year (Vianna *et al.* 2012). In summary, reductions of shark populations can lead to negative consequences in both an ecological and an economic sense.

Biological characteristics of Chondrichthyes, such as long generation times and low growth and reproductive rates (Cahmi *et al.* 1998), make them especially susceptible to overexploitation and extinction. Due to their low resilience, the majority of elasmobranch populations, particularly large sharks, decline more rapidly and are not able to respond as quickly as other fish to reductions in their populations caused by fisheries (Musick *et al.* 2000). Estimates of fishing mortality demonstrate that, in the current intensity of fishing pressure, large sharks and other sensitive species will become extinct in the near future (Myers & Worm 2005).

Recent worldwide attempts to organize the commercial capture of sharks, prompted by stock assessments, overfishing, or conservation needs have encountered numerous difficulties related to the establishment of fishing limits and controls (Pauly *et al.* 2013). Unfortunately, many sharks are frequently not recorded in fisheries statistics, and only 15% are identified and reported at the species level, according to the United Nations Food and Agriculture Organization (FAO; see Dulvy *et al.* 2008). The lack of species identification appears to be a chronic problem for industrial and artisanal fisheries, making the suitable management of fisheries, as well as the supervision of species protected by law, very difficult or even impossible to implement.

Although fisheries appear to be the main direct threat to sharks and rays, elasmobranch populations face a variety of additional threats, including habitat degradation, pollution, and climate change (Simpfendorfer *et al.* 2011). Two other problems, often neglected and underestimated, are mislabeling of shark meat by final sellers and shark attacks.

Consumption of shark meat has been recorded since the fourth century (Vannuccini 1999). Today, shark meat is eaten all over the world, although in some places there is a cultural barrier to its consumption (Vannuccini 1999; Bornatowski *et al.* 2013). While shark meat provides much of the protein requirement in poorer communities in developing countries, in developed countries it is viewed as a low-quality meat, and a name-change was necessary to overcome consumer resistance (Vannuccini 1999; WildAid 2007; Bornatowski *et al.* 2013). As exceptions, shortfin mako (*Isurus oxyrinchus*), thresher (*Alopias vulpinus*), and porbeagle (*Lamna nasus*) sharks have a highly palatable meat, comparable to swordfish (*Xiphias gladius*) meat in the United States and Europe (Vannuccini 1999).

Erroneous identification or intentional mislabeling of elasmobranchs is a large problem in some countries, creating a barrier to conservation (Bornatowski *et al.* 2013). The U.S. government issued rules to prevent mislabeling of shark meat. Previously, sharks were commercialized under other fish names, but now are sold under their real names (Vannuccini 1999). European Union regulations (Council Regulation 2000) require listing the species name on shark products in order to avoid fraud and to help conserve certain shark species (Blanco *et al.* 2008).

In addition to the two abovementioned problems (fisheries and meat mislabeling), the recent number of shark attacks is raising great concern among researchers. Shark attacks are a prominent problem in several countries, such as Australia, the United States, South Africa, and Brazil (International Shark Attack File [ISAF, https://www.flmnh.ufl.edu/fish/sharks/isaf/isaf.htm]). Shark attacks result in socioeconomic impacts, and some countries have worked to diminish these impacts through measures such as shark control programs (e.g., nets to avoid shark attack) in Australia and South Africa (Dudley 1997). Shark control programs aim to reduce populations of hazardous species that threaten humans, such as great white, tiger, and bull sharks. However, beyond killing large numbers of large sharks (apex predators that regulate inferior levels of food webs), these programs frequently lead to increased mortality of small elasmobranchs that are not dangerous, in addition to teleost fish, marine turtles, whales, dolphins, etc. (e.g., Dudley & Cliff 2003; 2010). Aside from the institution of shark attack control programs, public outcry after shark attack incidents frequently leads governments to take actions to kill sharks (Neff & Yang 2013). For instance, recent fatal shark attacks in Western Australia led the government to develop a plan to cull aggressive sharks (mainly great whites) in order to prevent attacks on humans (Cressey, 2013). In summary, both shark attack controls (nets or killing of sharks) and meat mislabeling amount to fishing on a large scale, further threatening the elasmobranch group.

Based on these questions, in this article we use Brazil as an example to focus on these three critical problems related to shark conservation: industrial and artisanal fisheries, shark attacks, and mislabeling in markets. We discuss these situations, highlighting brief examples and conservation barriers. The main goal is to present these problems and provide, effective solutions.

Industrial and artisanal fisheries: a case study from Brazil

Brazil is the fifth largest country in the world, with an exclusive economic zone covering ~4.5 million km^2, and a coastline of 8,500 km (Brasil 2011). Numerous artisanal fishing communities and industrial fishing harbors (e.g. Belém, Natal, Santos, and Itajaí) are found in coastal areas. However, some fisheries along the coast are poorly documented, and the broad identification levels of landed species (e.g. "sharks or rays") at nearly all sites makes species-specific regulation very difficult (Bornatowski *et al.* 2011; 2013). The Itajaí harbor, for instance, one of the main industrial harbors in southern Brazil, landed 2,353 tons of elasmobranchs in 2010, with over 85% not identified at the species level (UNIVALI/CTTMar 2011). This situation is even worse in artisanal fisheries (Sparre & Venema 1997; Costa *et al.* 2003). Approximately one million artisanal fishermen are recorded along the Brazilian coast (considering freshwater and marine areas), and small-scale fisheries are responsible for 45% of the national fishery production (Brasil 2011). The difficulty in monitoring all fishing communities along the Brazilian coast and obtaining accurate information regarding what is captured is enormous,