Fishing for Answers: How Marine Wildlife and Commercial Fishing Overlap

New Technology Can Help Protect Marine Wildlife

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Executive Summary

Every year, between 63 and 273 million sharks are killed in fisheries around the world. These species are both targeted and incidentally caught by legal and illegal fishing. In order to fully assess how shark populations are faring, we must first know how often, when and where they come into contact with fishing gear. Oceana partnered with shark researchers to tag 10 blue sharks off the East Coast of the United States and then used Global Fishing Watch to track their movements in relation to commercial fishing activity. The sharks' tracks were added to a custom Global Fishing Watch workspace (http://globalfishingwatch.org/map/workspace/sharks-v2) to create an interactive map for the public to visualize the interactions of these sharks with fishing vessels. Over a 110-day period, two of the tagged sharks surfaced near three different vessels that were likely fishing. Combining tagged animal data sets with fishing activity data in Global Fishing Watch represents a new frontier in ocean conservation that scientists and fishery managers alike may be able to use in the future. While studies have explored shark-vessel overlap with private Vessel Monitoring System (VMS) data, this is one of the first case studies that uses public Automatic Identification System (AIS) data. Oceana used Global Fishing Watch to demonstrate the power and promise of new technologies in helping fisheries managers and others improve the management of ocean resources to make our oceans rich, healthy and abundant.

Introduction

Sharks and their relatives are found in waters throughout the world, from deep waters to coastal shallows, tropical to frigid waters, and marine to freshwater environments.[1,2] In every habitat where sharks are found, they face new threats. These species run the gauntlet when it comes to fisheries interactions, encountering hooks and nets across the world. In fact, overfishing is the main reason why one in four species of sharks and their relatives are threatened with extinction[3] and it is estimated that between 63 and 273 million sharks are killed every year in fisheries around the world.[4]

There are over 400 species of sharks, many of which are the target of artisanal, recreational and commercial fisheries for their fins, meat, liver oil and more.[3] They also face the threat of becoming unintentionally caught by fishing gear targeting other fish. This bycatch, or the incidental catch of non-target fish and ocean wildlife, often discarded at sea, can result in the injury or death of the non-target species like sharks.[5] It is estimated that the number of sharks caught as bycatch in high-seas fisheries around the world is equal to nearly 50 percent of the reported catches from commercial fisheries.[6] However, shark catches—whether targeted, incidental or discarded—are frequently underreported and not species-specific, meaning that the estimates of shark mortality every year are likely underestimates.[4,6,7]

Many species of shark exhibit traits that make them especially vulnerable to overfishing and population declines, such as long lifespans, late age of maturity and having few young.[8–11] A comparison of 26 shark populations to 151 other fish populations determined that sharks face twice the risk of extinction resulting from fishing pressure than do other fish.[12] For example, a single swordfish (*Xiphias gladius*) reaches sexual maturity around five years of age[13] and produces millions of eggs at a time,[14] whereas some species of shark do not mature until they are over 10 years old, and some have as few as two pups per year.[15]

Removal of these predators from ocean ecosystems could create a domino effect of unintended consequences. Sharks serve as the sole predator of certain marine reptiles, marine mammals, seabirds and even other sharks,[16] and provide key ecosystem services such as cycling nutrients, removing invasive species, and cleaning up reefs by scavenging.[17] Using models, some studies have predicted that a decrease in shark populations is not only potentially damaging to the ocean ecosystem, but could also hurt commercial fishers, as their target species become depleted due to unchecked growth of mid-level predators.[16,18,19]

Proper management of these species requires a full understanding of the threats sharks face every day. One emerging method for documenting shark mortalities from fishing gear in the open ocean is through satellite telemetry, which relays information about the location of a tagged shark. A recent study used this technique to investigate fishing mortality on shortfin mako sharks from March 2013 through May 2016. The researchers deployed 40 tags which revealed that 30 percent of the sharks they tagged were caught over the course of the study, reinforcing the notion that the number of sharks killed by fishing each year may be greatly underestimated.[20]

Global Fishing Watch, an organization committed to increasing transparency in the fishing industry, developed a technology platform that can support ocean conservation; it allows users to see commercial fishing activity anywhere in the world, in near real-time, for free. Global Fishing Watch uses public broadcast AIS data, which is transmitted autonomously by vessels every few seconds and collected by satellite and terrestrial receivers, to show the movement of vessels over time. Using vessel movement behaviors such as speed, direction and rate of turn, Global Fishing Watch fishing detection algorithms determine the fishing activity of more than 60,000 fishing vessels worldwide. This global feed of fishing activity—which takes place in every ocean, day and night, all around the world—is provided to the public in an easy to use, web-based map (http://globalfishingwatch.org/).

Through a partnership with shark researchers Dr. Austin Gallagher from the conservation non-governmental organization Beneath the Waves and Dr. Neil Hammerschlag from the University of Miami, Oceana used Global Fishing Watch data and blue shark satellite telemetry to examine the overlap of fishing activity with shark locations in the continental shelf area south of Nantucket Shoals in the Northwest Atlantic Ocean. This case study demonstrates the potential of technologies like Global Fishing Watch to help enable researchers and fisheries managers to study the interactions between satellite-tagged marine animals and fishing vessels.

Case Study – Blue Sharks

The blue shark (*Prionace glauca*) is a relatively abundant pelagic shark found in temperate and tropical waters around the world.[21] This wide spread species is frequently encountered in fisheries operating on the high seas due to their preference for open-ocean habitats. In fact, blue sharks dominate shark bycatch in longline fisheries, making up between 50 and 90 percent of shark bycatch in many regions of the world.[22]

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The management of blue sharks is complicated by the fact that they frequently travel between national waters controlled by countries and those of the high seas.[23] In the Northwest Atlantic, this species is the most frequently caught shark in U.S. pelagic longline operations[24] and the most frequently captured large shark in Canadian waters.[23]

A clearer understanding of potential interactions between blue sharks and fishing vessels could allow for a more accurate assessment of bycatch and a better understanding of the risks to blue sharks. While a recent stock assessment reported that blue sharks in the North Atlantic are not overfished and that overfishing is not occurring, there is a high level of uncertainty due to a lack of data.[25] This uncertainty stems from the fact that blue sharks have little commercial value and therefore many that are caught are discarded without any record of the animal ever being captured.[23]

Oceana and partners tagged 10 adult male blue sharks in June 2016. A SPOT-6 (Specific Position or Temperature) transmitter was affixed to the dorsal fin of each shark and monitored their movements in high-resolution from June to September 2016 in the Northwest Atlantic Ocean. SPOT tags are designed to communicate location information with satellites when the tag is no longer underwater. This means that the dorsal fin of the shark must break the surface the water line to transmit any information.

Over a 110-day period, Oceana identified four occasions where a tagged blue shark encountered a vessel while it was likely fishing[A] (Table 1). These four encounters occurred when two of the tagged sharks surfaced near three different fishing vessels. An encounter between one tagged blue shark and a fishing vessel was determined when both were located less than one kilometer from each other within the same hour on the same calendar day.

Table 1: Tagged Blue Shark Data

Shark Tag ID	Total Length (cm)	Release Date	Days Transmitted	Number of Encounters	Closest Encounter with a Fishing Vessel*
159322	254	6/15/2016	68	-	
159328	281	6/30/2016	45	-	
159329	288	7/6/2016	29	-	
159316	262	7/7/2016	50	-	
159327	254	7/7/2016	66	-	
159318	313	7/12/2016	32	-	
159325	239	7/27/16	37	1	0.5
159312	266	8/7/2016	46	-	
159319	270	8/9/2016	41	3	0.11
159324	240	8/15/2016	30	-	

*Minimum distance (in miles) between the shark and a vessel while it was likely fishing.

[A] Any and all references to "fishing" should be understood in the context of Global Fishing Watch's fishing detection algorithm, which is a best effort to determine "apparent fishing effort" based on vessel speed and direction data from the Automatic Identification System (AIS), collected via satellites and terrestrial receivers. As AIS data varies in completeness, accuracy and quality, it is possible that some fishing effort is not identified and conversely, that some fishing effort identified is not fishing. For these reasons, Global Fishing Watch qualifies all designations of vessel fishing effort, including synonyms of the term "fishing effort," such as "fishing" or "fishing activity," as "apparent," rather than certain. Any/all Global Fishing Watch information about "apparent fishing effort" should be considered an estimate and must be relied upon solely at your own risk. Global Fishing Watch is taking steps to make sure fishing effort designations are as accurate as possible.

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The sharks' tracks were added to a custom Global Fishing Watch workspace to create an interactive map for the public to visualize the interactions of these sharks with commercial fishing vessels (usa.oceana.org/global-fishing-watch-sharks) (Figure 1). While studies have explored shark-vessel overlap with private VMS data, this is one of the first case studies using public AIS data for this purpose. Oceana found that 20 percent of the tagged blue sharks encountered vessels that were likely fishing during the three months that the 10 tags transmitted data.

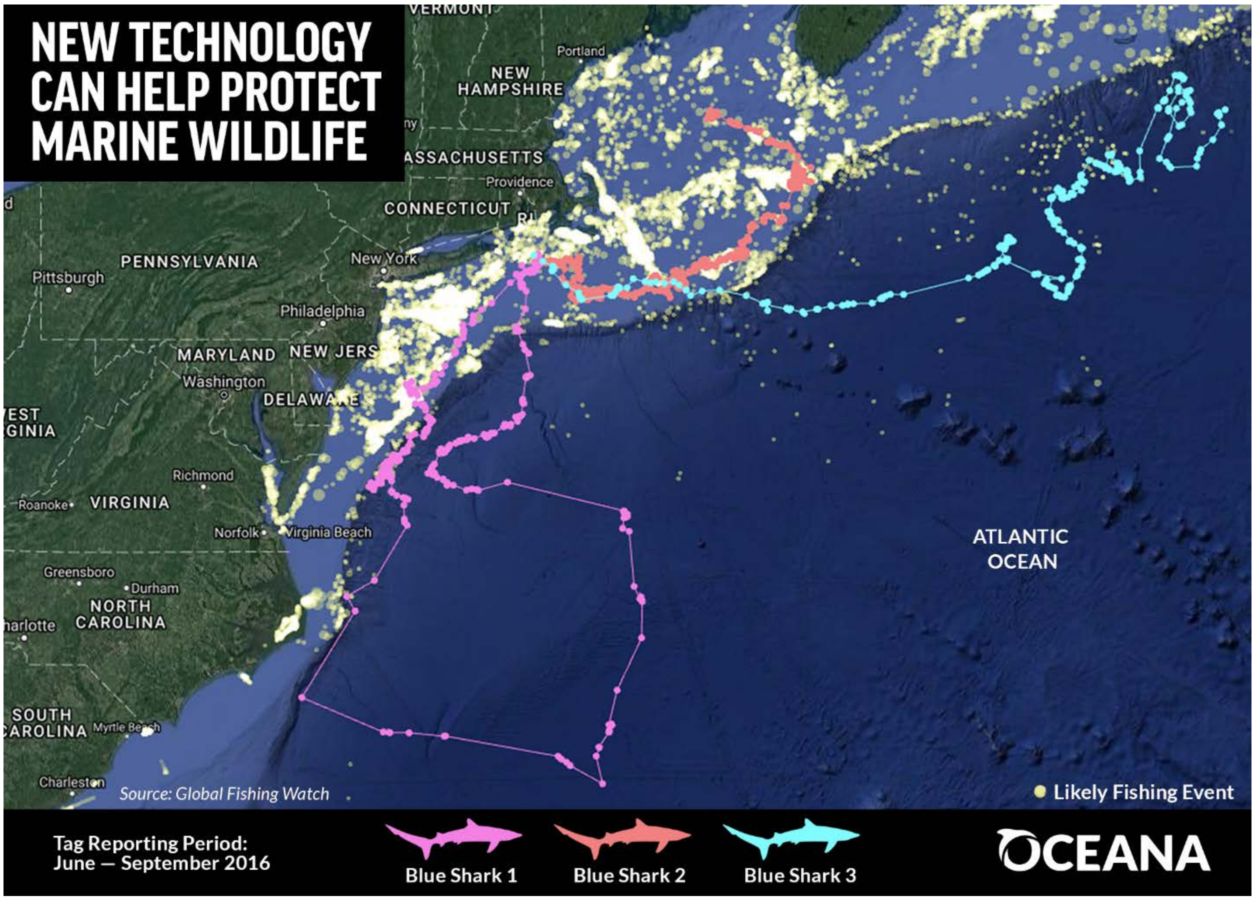

Figure 1: Example of a Global Fishing Watch workspace showing the interactions between three tagged blue sharks and commercial fishing activity in the Northwest Atlantic Ocean, from June through September 2016.

As of March 2, 2015, all commercial fishing vessels greater than 65 feet within the United States are required to have an AIS device properly installed and operational, per guidelines set forth by the International Maritime Organization (IMO).[26] AIS data acquisition provides a novel approach to investigate interactions between vulnerable marine species and commercial fishing operations, as it allows higher-resolution analysis than VMS data. However, the use of AIS is not limited to the United States fishing fleet, as the IMO requires all ships over 300 gross tonnage to be equipped with AIS. Scientists can use AIS data to investigate the coincidence of tagged animals with commercial fishing fleets around the world.

Management Implications and Future Uses

Bycatch and unsustainable catch can have detrimental effects on populations of long-lived species such as sharks. For instance, the dusky shark population in the Atlantic and Gulf of Mexico have declined by an estimated 65 percent.[27] The species was listed as a "Species of Concern" by the National Marine Fisheries Service in 1997 and retention was prohibited in 2000 to help the population recover. However, a 2016 stock assessment found that the dusky shark continues to be overfished and subject to overfishing, driven by continued bycatch.[27] For example, bottom longline, handline and troll fisheries for reef fish and snapper-grouper in the southeast U.S. region incidentally caught an average of 3,872 dusky sharks per year between 2006 and 2010.[28]

The vulnerability of sharks and their relatives to overfishing emphasizes the need to minimize interactions between sharks and fishing gear. By tracking these species and overlaying their locations with commercial fishing data like that provided by Global Fishing Watch, researchers and fisheries managers could effectively examine the areas where species like the blue and dusky sharks are caught with frequency to predict bycatch risk and implement management measures that would protect vulnerable species.

Interactions between vessels and marine life could lead to more effective time-area or hotspot closures, which close areas of fishing during periods of time when bycatch species are most likely to be caught. Information on interactions could also lead to gear modifications that can be effective in reducing bycatch in certain areas. These conservation and management measures are most effective with high quality information about shark location and fishing activity as exemplified in this report.

Overfishing and bycatch mortality are of concern not only for sharks, but also for many species of fish, marine mammals and sea turtles. Platforms like Global Fishing Watch represent a new frontier in fisheries research and management; tools like this can be used to help protect marine wildlife. Oceana used Global Fishing Watch to demonstrate the application of new technologies in helping fisheries managers and others improve the management of ocean resources to make our oceans rich, healthy and abundant.

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