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Short communication

Banning is not enough: The complexities of oceanic shark management by tuna regional fisheries management organizations

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ABSTRACT

Recently, declining populations of several pelagic shark species have led to global conservation concerns surrounding this group. As a result, a series of species-specific banning measures have been implemented by Regional Fishery Management Organizations (RFMOs) in charge of tuna fisheries, which include retention bans, finning bans and trading bans. There are both positive and negative aspects to most management measures, but generally, the positive aspects outweigh the negatives, ensuring the measure is beneficial to the resource and its users in the long term. Banning measures are a good first step towards the conservation of pelagic shark species, especially since they improve conservation awareness among fishers, managers and the public. Measures that impose total bans, however, can lead to negative impacts that may jeopardize the populations they were intended to protect. The majority of pelagic shark catches are incidental and most sharks die before they reach the vessel or after they are released. The legislation set out by RFMOs only prevents retention but not the actual capture or the mortality that may occur as a result. Managers should be fully aware that the development and implementation of mitigation measures are critical for a more effective conservation strategy.

1. Introduction

As populations of highly migratory species decline due to over-exploitation or other human induced causes, management measures are often implemented to aid their conservation and restore populations to pre-existing levels (Hoffmann et al., 2010). Such measures have a variety of forms, typically linked to the level of concern surrounding the population in question. Generally, as concerns become increasingly severe, management measures follow suit and often conclude with total bans

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on harvesting and global trade of a species. While these measures are generally believed to aid in species conservation, they can, at times, lead to increased pressure on the population at risk (Rivalan et al., 2007).

Recently, declining populations of several pelagic shark species have led to global conservation concerns surrounding this group (Fowler et al., 2005; Dulvy et al., 2008; Aires-da-Silva and Gallucci, 2008; Cortés et al., 2010). These sharks are both targeted and taken incidentally as bycatch by a range of fleets from coastal artisanal to industrial vessels operating in distant waters (Bonfil, 1994; Worm et al., 2013). An inherent issue with exploitation of elasmobranch species, as compared to their teleost counterparts, is their low rebound capacity resulting directly from their characteristic life history traits of slow growth, late maturation and low fecundity (Cortés, 2000). As such, this group is generally far more vulnerable to overfishing than teleost fish species (Musick et al., 2002; Compagno et al., 2005).

With the increasing conservation concern over this sensitive group, a series of species-specific banning measures have recently been established by Regional Fishery Management Organizations (RFMOs) responsible for the management of tuna fisheries. These measures include retention bans, finning bans and trading bans. There are both positive and negative aspects to most management measures, but generally, the positive aspects outweigh the negatives ensuring the measure is beneficial to the resource and its users in the long term. Management measures based on retention, finning or trading bans are no different. Here we highlight both the benefits and drawbacks of such measures, in order to assess their overall efficacy and long-term benefit to populations.

2. Banning measures

Fisheries that target widely distributed and highly migratory species are managed by international commissions, of which cooperating countries/parties are members. There are five such commissions (RFMOs) that regulate the world's tuna fisheries, each with jurisdiction over an ocean/ocean region or target species: the International Commission for the Conservation of Atlantic tuna (ICCAT), the Indian Ocean Tuna Commission (IOTC), the Western and Central Pacific Fisheries Commission (WCPFC), the Inter-American Tropical Tuna Commission (IATTC), overseeing fishery activity in the eastern Pacific Ocean, and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), overseeing all fisheries targeting southern bluefin tuna (*Thunnus macoyii*). Aside from tuna species, these RFMOs are also usually responsible for the management of any other species caught in association with tuna fisheries. Management measures generally stem from the results of annual stock assessments and the advice from scientific committees linked to RFMOs. These measures are set out in the form of recommendations or resolutions, which contracting parties are then required to implement and report upon.

To date, several species-specific management measures have been developed under the tuna RFMOs that pertain to the incidental capture of pelagic sharks. These measures are hereafter referred to as banning measures. Generally, they stipulate that all contracting parties shall prohibit retention, transshipment, landing or storing any part, or whole carcass, of the species in question. Additionally, some of these measures require captured sharks to be promptly released unharmed and/or further state that trading, selling or offering for sale is also prohibited (Table 1). As a result, oceanic whitetip (*Carcharhinus longimanus*), silky (*C. falciformis*), thresher (*Alopias spp.*) and hammerhead (*Sphyrna spp.*) sharks fall under such resolutions in at least one ocean (Table 1). These measures were all developed fairly recently by tuna RFMOs (2010–2013). The oceanic whitetip shark is the only species covered by such measures across all oceans.

In addition to RFMO management measures, international treaties also regulate the trade of certain marine species. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is one such treaty and plays an important role in managing wildlife. CITES represents an international agreement among governments that aims to ensure that international trade of wild fauna and flora does not threaten their survival. In accordance with this convention, the international trade of specified species can either be closely controlled (species listed on appendix II) or completely banned (appendix I), depending on its population status or vulnerability. During the most recent meeting of CITES (March 2013), the oceanic whitetip and hammerhead sharks were included in appendix II (CoP16 Prop. 42 and 43), requiring their international trade to be closely controlled.

3. In what scenario can banning measures be effective?

Banning the retention and trade of pelagic sharks can drastically decrease their fishing mortality in fisheries where they are directly targeted. Essentially, the aim of these measures is to give the stocks the opportunity to recover to pre-exploitation levels. It is well known, however, that the great majority of pelagic shark mortality results from their incidental capture in high-seas pelagic longlines, gillnets and purse seine fisheries that primarily target tuna and tuna-like species (Gilman et al., 2008; Bonfil, 1994). Nevertheless, sharks are undeniably considered a valuable bycatch in many fleets and are increasingly becoming a target as well (Hareide et al., 2007). The implementation of banning measures in these fisheries not only encourages fishers to modify their current practices, but also prevents these species from shifting from an incidental catch to a specific target.

An increasing number of marine populations are showing signs of recovery after an advance on conservation efforts, especially through measures that ban trade or any exploitation activity (Lotze et al., 2011). Marine mammals represent the group with the greatest results in terms of conservation success for this ecosystem. A recent study has shown that 42% of 92 spatially non-overlapping marine mammal populations are significantly increasing as a result of measures that ban their

Table 1
Pelagic shark species currently under banning measures on tuna RFMOs.

		Shark species				
		Oceanic whitetip	Silky	Bigeye thresher	Thresher spp.	Hammerhead spp.[a]
ICCAT	Retain	×	×	×		×
	Fin	×	×	×		×
	Trade	×		×		×
	Release		×	×		×
	REF	**Rec.10-07**	**Rec.11-08**	**Rec.09-07**		**Rec.10-08**
IOTC	Retain	×			×	
	Fin	×			×	
	Trade				×	
	Release	×			×	
	REF	**Res.13-06**			**Res.12-09**	
WCPFC	Retain	×	×			
	Fin	×	×			
	Trade					
	Release	×	×			
	REF	**CMM 11-04**	CMM 13-08			
IATTC	Retain	×				
	Fin	×				
	Trade	×				
	Release	×				
	REF	**Res.11-10**				

[a] The hammerhead shark species *Sphyrna tiburo* is excluded from this measure.

exploitation and trade (Magera et al., 2013). Whales are, perhaps, the best example of this success. The banning regulations set by the International Whaling Commission (IWC) have reduced whale hunting dramatically and brought most exploited species out of extinction risk (Magera et al., 2013). Some humpback whale populations from the Southern Hemisphere are even expected to reach their estimated pre-whaling abundance levels over the next decade (Gales et al., 2011).

Such banning measures, however, can also bring unintended negative effects. By prohibiting their trade, the products from these species may develop into rare and luxurious commodities. This perceived rarity could lead to increased consumer demand, making their illegal trade highly profitable. In extreme cases, when demand is sufficiently high, the protected species could eventually be driven to extinction (Courchamp et al., 2006; Hall et al., 2008). There is strong evidence that demonstrates how moving a species to a more restrictive CITES appendix can lead to a drastic increase in its illegal trade (Rivalan et al., 2007). During the transition period, between initial announcement of such a measure and its final implementation into the legislation, trade volumes have been observed to increase up to 135% (Rivalan et al., 2007). Furthermore, the black market price of rhinoceros horn increased by more than 400% within 2 years of their listing under Appendix I (Rivalan et al., 2007).

Shark fins are highly valued and their trade is currently very profitable. The global value of this market ranges between approximately US$400 and 550 million per year (Clarke et al., 2007). Being a luxury commodity in Asian cuisine, these species could become highly vulnerable should their availability decrease. Fin traders generally distinguish the fins of different shark species (Clarke et al., 2006) and the rarity of a particular species could be capitalized upon, although consumers do not currently make that distinction. Owing to their large rounded shape and characteristic white marking (Compagno, 1984), the fins of the oceanic whitetip shark are among the easiest to identify (Clarke et al., 2006), meaning its vulnerability could increase to dangerous levels should their rarity become an attractive quality. Additionally, in light of the multitude of conservation regulations set forth for this species of late, awareness regarding its threatened status has clearly increased. Once considered amongst the most abundant oceanic sharks, the oceanic whitetip is now commonly perceived as rare and there is a wide consensus that populations are decreasing (Baum and Blanchard, 2010; Clarke et al., 2012; Rice and Harley, 2012). Although future scenarios are difficult to predict, it seems that many of the rarity-associated black market factors described above are possible for this shark species, especially in light of the global ban on its retention in pelagic fisheries under tuna RFMO management.

4. In what scenario are banning measures not enough?

As stated above, pelagic shark mortality is primarily due to their incidental capture in high seas fisheries as a result of the shared habitat of pelagic sharks and tunas. Since retention and trade are banned but not the actual capture, banning measures in their current form will have little impact on Fisher-behavior. As such, capture rates are unlikely to change. While mortality rates are both gear and species specific (Skomal, 2007; Campana et al., 2009; Clarke et al., 2013), they are often high as a large portion of incidentally caught sharks are already dead/dying by the time they reach the vessel or after release (Rogan and Mackey, 2007; Poisson et al., 2014a; Hutchinson et al., 2015).

In the case of the tropical tuna purse seine fishery, the conditions in the sack of the net creates a highly stressful environment, with low oxygen levels and increased temperatures, which directly affect the mortality of the catch (Hall and Roman, 2013). Subsequently, the brailing process further reduces the chances of survival as sharks are compressed between the 2 and 8 tons of tuna in the brail (scoop net used to load the catch onboard the seiner). Brailled silky sharks were found to have an overall mortality rate of 85%, including the ones that appeared to be in relatively good condition upon release (Poisson et al., 2014a; Hutchinson et al., 2015). Scalloped hammerhead sharks exhibited one of the lowest survival rates compared to other pelagic sharks when caught on pelagic longlines (Gallagher et al., 2014). The authors considered that the incidental capture of this species in tuna longline fisheries played an important role in the substantial population decline reported for the Northwest Atlantic (Baum et al., 2003).

While it is true that species with high rates of live caught individuals as well as post release survival could benefit from banning measures, in cases similar to the silky and scalloped hammerhead sharks the outcome of these measures alone would be rendered biologically ineffective for the recovery of the stocks. Furthermore, should illegal trade prices be sufficiently high, fishers may be willing to take the risk of prosecution and retain the sharks (or their fins) for commercialization.

The complication associated with the mixed capture of target and bycatch species preclude banning measures from being the final solution for curbing mortality and aiding the recovery of pelagic shark stocks. However, this does not mean that these measures provide no benefits. Whenever a banning measure is established, it directly implies that the population concerned is under severe threat. As such, the establishment of a ban indirectly results in improved public awareness regarding the species' conservation risk and that extreme action is required for its protection. Essentially, such bans can act as an awareness campaign to alert fishers and consumers who play a crucial role in conservation. In 1990, following strong media pressure regarding the mortality of dolphins in the eastern Pacific Ocean by tuna purse seine fisheries, the US Congress approved the Dolphin Protection Consumer Information Act establishing the use of a "dolphin safe" label on tuna cans which contained tuna not caught in association with dolphins (Joseph, 1994). A market analysis showed that media pressure and subsequent implementation of dolphin-safe labeling affected consumer behavior (Teisl et al., 2002), providing an insight in how public awareness can be a useful tool for wildlife conservation. This public pressure led to the development of a mitigation technique, the backdown process, where the seiner is put into reverse elongating the net and causing the cork line to sink at one extremity. This maneuver allows dolphins to safely swim away over the sunken corks. Thanks to the backdown process, fishers can still target tuna schools associated with dolphins. The technique is mandatory for tuna purse seiners fishing in the eastern Pacific Ocean (IATTC) and its compliance is controlled thanks to the presence of onboard observers.

Pelagic shark populations could benefit significantly from an increase in public awareness. In the not too distant past, sharks were seen as little more than a threat to humans. Although this perception is slowly changing (Simpfendorfer et al., 2011), the need for continued efforts to raise public awareness regarding conservation requirements is essential and the establishment of species specific bans will aid in this effort.

5. Potential solutions

The incidental nature of shark catches in tuna fisheries worldwide suggest that mitigation measures are an essential tool for an effective conservation strategy. A set of integrated measures will more effectively aid in the conservation and recovery of threatened pelagic sharks than banning measures alone. These measures should mainly include: (1) the development of alternative fishing techniques; and (2) the reduction of fishing effort, e.g. developing spatial or temporal management measures such as closed areas/seasons.

Developing techniques that prevent the capture of pelagic sharks is critical. Gear modifications have been proved effective in reducing capture and mortality of some bycatch species, such as dolphins, seabirds and marine turtles (Coe et al., 1984; Gilman et al., 2006; Løkkeborg, 2011; Andraka et al., 2013). Gear modifications to mitigate pelagic sharks capture represent a real challenge as their distributions and behavior have strong similarities to that of targeted species. However, some techniques that have been proposed could be investigated further. Fishing gears with the highest incidence of incidentally caught sharks are gillnets, pelagic longlines and purse seiners. Gillnets together with longlines are responsible for the greatest impacts, but very little research has been done to develop mitigation methods to reduce shark bycatch in this fishing gear (Oliver et al., 2015). More research has been conducted on longline and purse seine gear.

In pelagic longline fisheries, epipelagic species, such as the oceanic whitetip shark, could benefit from the removal of shallow hooks (Tolotti et al., 2013). This simple measure has been shown to reduce the capture of several bycatch species, while also increasing the number of hooks available for the target species (Kitchell et al., 2004; Beverly et al., 2009; Watson and Bigelow, 2014). Rare earth metals are a potential tool to mitigate shark bycatch, as they can work as a repellent due to the strong electric field they produce the in water (Stroud, 2007). Much research is still required, however, as this method seems highly complex and results can be conflicting as well as species specific (Stoner and Kaimmer, 2008; Robbins et al., 2011; Hutchinson et al., 2012; Godin et al., 2013).

To reduce the fishery induced mortality of pelagic sharks caught by tropical tuna purse seiners, it is imperative to direct research efforts at finding ways to release them before the retrieval of the net or to attract them away from the tuna aggregation before the net is set. A natural segregation between sharks and tuna inside the net has been repeatedly observed, which could allow for the establishment of a release system (Itano et al., 2012). Preliminary tests were conducted in the Western Pacific ocean and scientists believe this mitigation measure has potential (Itano et al., 2012).

Another relevant issue with purse seine fisheries that has recently been brought to light is the exceptionally high rate of silky sharks becoming entangled on the nets hanging below fish aggregating devices (Filmalter et al., 2013). The construction of such devices should be controlled and the use of nets needs to be banned. In fact, several RFMOs have recently adopted recommendations in this regard, which stipulate that the use of netting in the construction of fish aggregating devices should be avoided (ex.: IATTC Res.13-04, IOTC Res.13-08).

The handling of sharks after capture plays an important role in the survival rate of released individuals. To increase their chances of survival, best handling practices guides need to be developed for each fishery (see (Poisson et al., 2014b) as an example). Naturally, the development of such guides has to be paired with post release survival studies. Investigating post-release mortality is also an essential part when assessing the efficacy of banning measures and, although costly, require significant research attention. Once best practices guides are developed, incentives or disincentives should be promoted in order to facilitate the adoption of good practices by fishers. Market related incentives, such as ecolabels, could be an encouraging tool (ex. MSC certification and ISSF PVR).

Time area closures have helped the recovery of stocks of a variety of species, from marine invertebrates, such as mollusks, to teleost fishes (Lester et al., 2009; Roberts, 2012; Kerwath et al., 2013). Although most of the successful experiences come from coastal fisheries, positive results encourage the investigation of implementing such measures for pelagic sharks. The great challenge with pelagic time area closures resides on the high mobility of pelagic species and on the lack of data concerning this complex ecosystem (Game et al., 2009). This means that the protected area would have to have exaggerated proportions or target smaller areas where fishing activities would provoke higher impacts, such as nurseries and/or spawning zones (Kaplan et al., 2010). Considering the high cost of enforcement, a targeted time area closure seems more feasible. Watson et al. (2008) found some promising results regarding silky shark bycatch in the Eastern Pacific Ocean tuna fishery. The authors found that juveniles silky sharks are mostly concentrated north of the equator and estimated that area closures could have reduced up to 33% of the species bycatch while compromising only 12% of the tuna catch. A similar hotspot of juvenile silky sharks has also been identified in the Indian Ocean and authors noted that this area does not overlap with the highest catch per unit of effort area of the purse seine fisheries (Amandè et al., 2011).

Finally, monitoring is key for any successful management system. There is a history of poor reporting of shark catches, largely due to their incidental nature (Bonfil, 1994; Camhi et al., 2008; Clarke, 2013; Oliver et al., 2015). Despite improvements in recent years (FAO, 2014), notably due to RFMO requirements to report shark bycatch (ex. ICCAT Rec.04-10), a banning measure may jeopardize this trend. Under these regulations captains may be inclined not to report the capture of a banned species at all as to avoid repercussions, especially if they have the intention of illegal commercialization. The current low coverage level of independent observers in most high seas fisheries makes this scenario particularly concerning (Worm et al., 2013).

Data deficiency is a paramount issue for fisheries management, as stock assessment methods rely largely on catch and effort time series data (Barker and Schleussel, 2005). To date, only a handful of stock assessments have been conducted for pelagic sharks (ICCAT, 2009; Rice and Harley, 2012, 2013). Additionally, the results of these assessments are usually interpreted with considerable caution due to the data deficiencies and the resulting high level of uncertainty of the assessments (Cortés et al., 2010). Until every vessel exploiting the high seas has some form of independent observer or observation system onboard, the reliability of such data will remain questionable. Standardized fisheries independent surveys could be a simple solution to overcoming this issue. Electronic observation systems still have limitations, especially regarding bycatch identification, but promising results indicate this system could also be a useful tool to improve both monitoring and data collection (Ames et al., 2007; Ruiz et al., 2014).

6. Final remarks

The problem faced in pelagic shark management is a direct result of the way fishermen catch their fish in an environment shared by target and bycatch species. The current fishing methods are not selective enough to avoid catching sharks. Banning measures in their present form do little to discourage the incidental capture of sharks and are unlikely to be effective enough, even with an increase in release numbers, to rebuild stocks. Banning measures are one form of management, but cannot be the only one applied. They are a positive initial step towards the conservation of endangered shark species. They act on a precautionary approach basis and also improve conservation awareness among fishers, managers and the general public.

Banning measures can provide positive outcomes to the conservation of pelagic sharks, but their effectiveness is directly linked to whether the species at issue is the target of the fisheries or a bycatch component (Fig. 1). For fisheries where sharks are bycatch, the banning measure would imperatively need to be accompanied by (i) high observer coverage and (ii) mitigation measures. Viewing banning measures as a final solution could result in lowered research incentives and hamper the further development of appropriate mitigation measures. Furthermore, without high observer coverage, such a measure could lead to less catch data, therefore less monitoring of the impacts of fisheries on these species, and less opportunities to improve our knowledge on the biology of these species at risk. We consider that the implementation of high observer coverage is urgent, especially on longline fisheries, as well as the adoption of measures that can reduce the fishing mortality of sharks by avoiding their catch and increasing their survival after release.

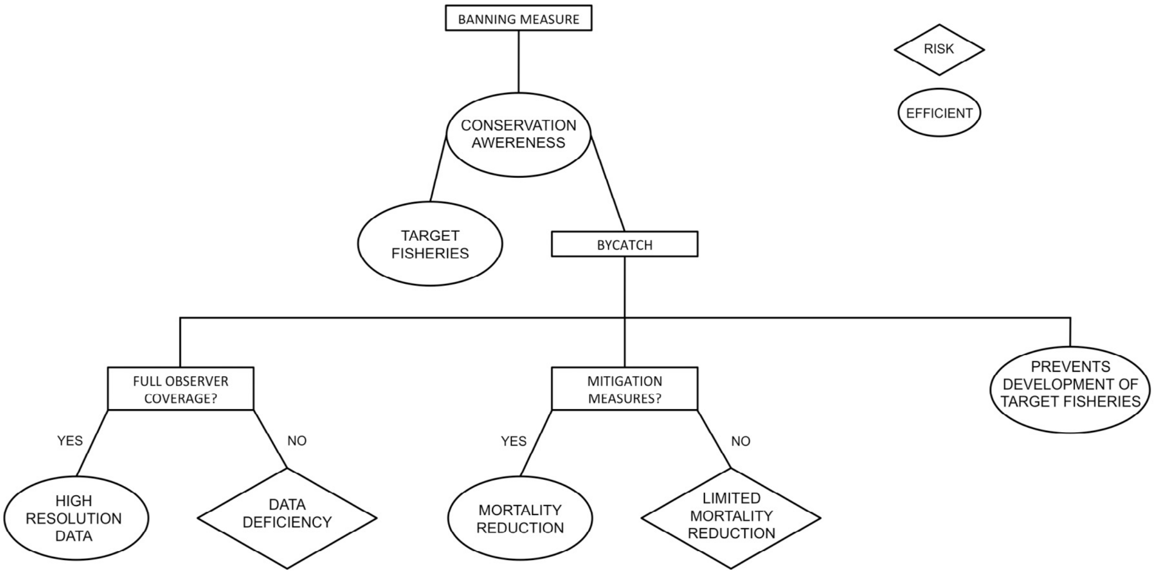

Fig. 1. Flow chart depicting the different scenarios where the banning measures can be effective or generate risks.

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