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Characterisation of shark bycatch from tuna longliners operating in the British Indian Ocean Territory (BIOT) between 2000 and 2010 from observer and vessel logbook data

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Executive Summary

Observer and vessel logbook data collected in the British Indian Ocean Territory (BIOT) were analysed to provide information on catch rates and species composition of sharks caught as bycatch in the longline fishery prior to 2010. Observer data, collected over 3 seasons between 2000 and 2003, showed that 4% of the catch (by numbers) was made up of sharks, with catch rates averaging 3.6 fish per 1,000 hooks. The majority were blue sharks (*Prionace glauca*) (52%), pelagic thresher sharks (*Alopias pelagicus*) (15%) and silky sharks (*Carcharhinus falciformis*) (14%) by number. Vessel logbook data from between 2006 and 2010, showed a fluctuation in the proportion of sharks caught (by numbers and weight) between 8-15% (mean= 11%) of total catch. Catch per unit effort (CPUE) by number varied between 0.69-1.68 (mean= 1.16) fish per 1,000 hooks; by weight, CPUE varied 23.61-44.13 kg (mean= 34.58 kg) per 1,000 hooks. Results were compared to reports from other areas in the Indian Ocean and found to be similar, particularly to the swordfish fishery in Reunion.

It was not possible to determine the reasons for the different shark catch rates between vessels, however information received from vessel masters revealed that the majority of sharks were caught on hooks closest to the buoys on the line where hooks were shallower. Vessels set deploying deeper sets (150m to 180m) are targeting bigeye tuna (*Thunnus obesus*), whereas shallower sets catch yellowfin tuna (*Thunnus albacares*) and more sharks. There was a weak negative correlation between the CPUE of sharks and bigeye tuna, and a weak positive correlation between the CPUE of sharks and yellowfin tuna. There is some circumstantial evidence that the banning of wire trace and shark finning measures introduced in 2007 may have influenced the observed downward trend in the reported catch of sharks in BIOT, although a lack of reliable data prior to this makes it hard to qualify.

Introduction

Prior to the declaration of the BIOT MPA, in March 2010, a licenced longline fishery targeting bigeye and yellowfin tuna operated within BIOT waters. During this time various management measures were brought in to promote the conservation of sharks, these included:

- A ban on the finning of sharks;
- A ban on wire trace;
- A ban on the retention or transhipment of shark fins; and
- A recommendation for the live release of all sharks caught.

Reporting requirements were also introduced from 2005 onwards, requiring all fishing vessels to record shark bycatch, both in numbers and weight, so the rates could be assessed over time. Furthermore, the longline fishery was subject to an observer programme over selected years where observers were required to record the detailed catch composition of sections of the line.

The following analysis uses observer data collected over 3 seasons between 2000 and 2003 and logbook data from 2005 up to the closure of the fishery in 2010 to summarise shark bycatch in terms of proportion, CPUE and species composition. An additional aim is to assess the effectiveness of the BIOT shark conservation management measures and provide a comparison with shark bycatch rates in other areas of the Indian Ocean.

Methodology

Hook surveys were conducted by observers on-board a total of 11 different longline fishing vessels, all targeting yellowfin and bigeye tuna in BIOT, over a period of three fishing seasons (from 2000/01 to 2002/03). Observers monitored all hooks during a portion of every haul while on board and recorded information on each hook as it was hauled, including presence or absence of fish and species identification.

Licenced vessels operating within BIOT were required to submit logbook data when fishing within the Fisheries Conservation Management Zone (FCMZ). From 2005 it was also mandatory for fishing masters to report not only the numbers of sharks caught but also the weight (prior to 2005 data on shark catches were only provided from the Japanese and Taiwanese fleet, and only by numbers). Only data for the period 2005-2010 has therefore used in this analysis. Some vessels recorded sharks under the general category of 'Sharks, rays, skates etc.', although it has been assumed that all records are for sharks as there was no requirement in BIOT legislation to record skates or rays. There was no record of sharks by species.

Vessels that recorded zero shark catches over their entire trip (9 vessels over the time period) or returned null values were excluded as it was unclear if this reflected their true catch level. This left a total of 1955 lines over 80 trips over the 6 year period that were used to calculate the proportion and CPUE for shark species in the catch. The number of trips per year are shown in Table 1.

Table 1 Number of vessels by year reporting shark bycatch.

Year	Number of vessels
2005	13
2006	13
2007	15
2008	13
2009	19
2010	7

Finally interviews were also conducted during vessel inspections by the Senior Fisheries Protection Officer (SFPO) during 2009 to collect information on different gear types and fishing strategies to attempt to determine why some vessels caught more sharks than others.

Results

Observer data 2000 – 2003

A total of 38,447 hooks were sampled and more than 4,084 fish were counted and identified. Target species yellowfin (29% by number) and bigeye tuna (26%) were the most frequently caught, though longnose lancet fish (25%) were also caught in large numbers. Rays (5%) and sharks (4%) together made up 9% of the catch (Figure 1).

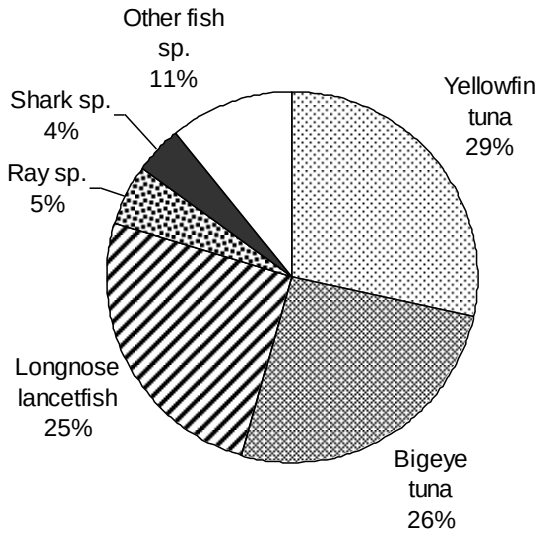


Figure 1 Composition of catch (by numbers) from hooks survey observations on longliners operating in the BIOT fishing zone from 2001-2003.

Catches of shark were predominantly blue shark (52%), though pelagic thresher (15%) and silky shark (14%) were also caught frequently (Figure 2). A total 217 rays were also caught, of which stingrays or butterfly rays comprised more than 85% by number.

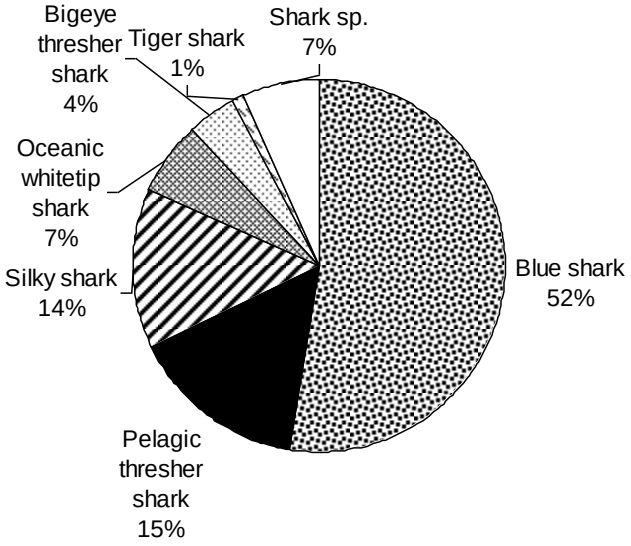


Figure 2 Shark catch species composition (by number) from hooks survey observations on longliners operating in the BIOT fishing zone from 2001-2003.

Mean CPUE of shark over the three seasons was 3.6 fish per 1,000 hooks. Broken down by species the CPUE of blue shark, at 2.06 fish per 1000 hooks, was approximately one-tenth of the CPUE for the target species (21.81 and 18.08 for yellowfin and bigeye tuna respectively). The CPUE for all other individual shark species was lower than 0.5 individuals per 1000 hooks (Figure 3).

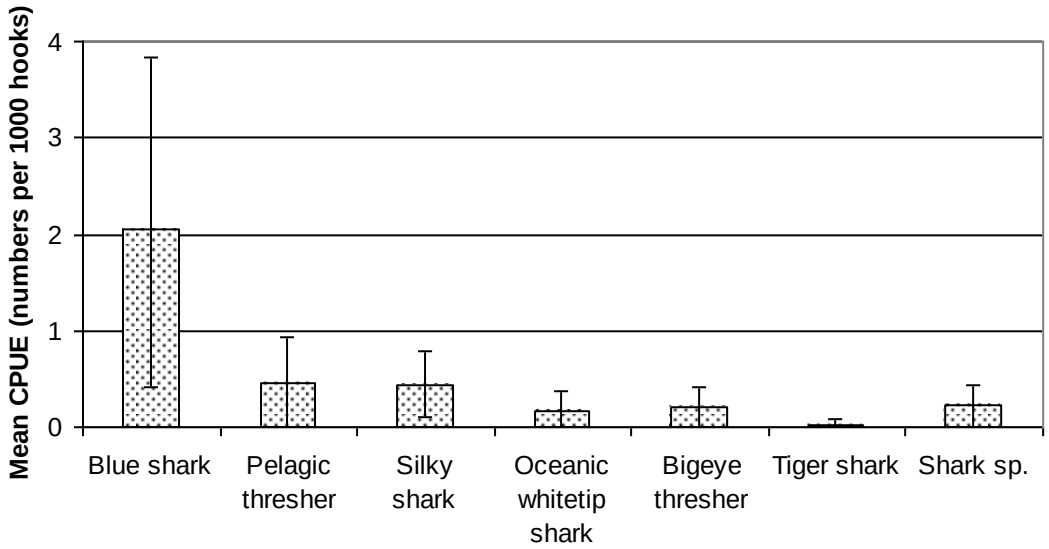
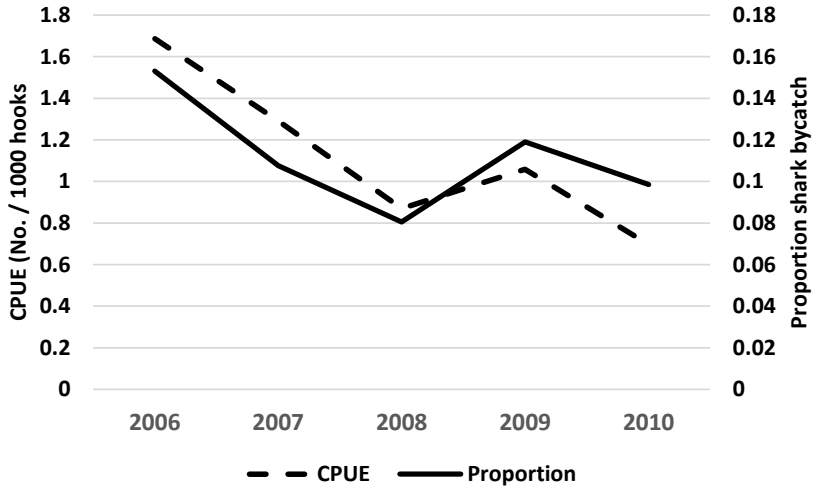


Figure 3 Mean CPUE of sharks (numbers per 1000 hooks) from hooks survey observations on longliners operating in the BIOT fishing zone from 2001-2003. (Bars are maximum and minimum values over the 3 fishing seasons)

Vessel logbook data 2005 – 2010

The catch rates of sharks as both CPUE and as a proportion of total catch are shown in Figure 4. Figure 4a) shows the catch rates in terms of numbers, with the CPUE being the number of sharks caught per 1,000 hooks and the proportion being the numbers of sharks caught as a proportion of the total numbers of fish caught, Figure 4b) shows the catch rates in terms of weights, with the CPUE being the weight of sharks caught (Kg) per 1,000 hooks and the proportion the total weight of shark caught as a proportion of the total catch weight. Analysis showed the catch rate in 2005 was around 2% (by numbers and weight) and was considered to be an anomaly, related to vessels adapting to the new reporting requirements, rather than a true reflection of the catches themselves. Therefore for the purpose of this analysis should was excluded. Since 2006 there has been a downward trend in both the proportion of total shark catch and the CPUE suggesting a true decrease in sharks being caught. In addition the trends were mirrored for both numbers and weight indicating that weights were being consistently recorded.

(a)



(b)

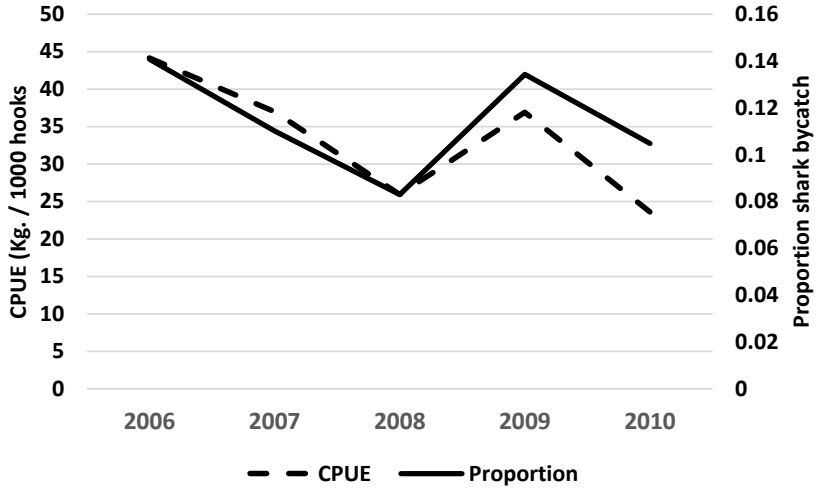


Figure 4 Reported shark catches in BIOT. a) The CPUE as numbers of sharks caught per 1000 hooks and the Proportion as numbers of sharks caught against total numbers of fish in the catch and b) The CPUE as weight (kg) of sharks caught per 1000 hooks and proportion as weight of sharks caught against total weight of catch.

The maximum CPUE on any individual line was 17.28 fish per 1,000 hooks, the minimum (on lines where catches were reported) was 0.27 fish per 1,000 hooks. There was a weak negative correlation (r = -2.419) between shark and bigeye tuna CPUE and a weak (r = 0.052) positive correlation between shark and yellowfin tuna CPUE.

Discussion and conclusions

Comparison with levels of shark bycatch from other parts of the Indian Ocean provide some context to the catch rates observed in BIOT. A comparison of bycatch rates from different areas in the Indian Ocean, based on reports made to WPEB between 2006 and 2013, is shown in Table 2. The mean catch rate of shark in BIOT waters (3.6 fish per 1000 hooks) was comparable to that experienced on vessels longlining for swordfish at the Reunion Islands, which were between 1.03-8.60 fish per 1,000 hooks between 1998 and 2011 (Poisson, 2007, Bach et al. 2012). By comparison, the catch rate of shark in BIOT was higher than that experienced in the Japanese Southern bluefin fishery in 2006 (0.27 fish per 1000 hooks) (Okamoto et al. 2006) and by Thai longliners in 2012 (0.50 fish per 1,000 hooks) (Luesrithawornsin & Wongkeaw, 2013), although both had reported a similar proportion of shark bycatch at around 4%. Blue shark was the most common species caught in BIOT, in common with Reunion, however mako, the most common species caught in Malagasy waters (Rahombanjanahary, 2013), did not appear in BIOT catches at all.

This report shows that the catch rate of sharks in BIOT declined steadily between 2006 and 2010 (Figure 4). Different factors that may influence the rate shark catches (and mortality) in the Marshall Islands tuna longline fishery have been suggested by Bromhead et al. (2012). These depth of fishing, water temperature, fishing at night and moon phase, presence of seamounts and proximity to land. It concluded that the most effective measures were those aimed directly at reducing catch rates (through, among other things, banning wire trace) and increasing survivorship port release (banning of shark finning). Whilst it has not been possible in this analysis to identify all the causes the observed decline, it is likely that the management measures introduced in BIOT in 2007 would have had a significant influence as they have been shown to have been the most effective at reducing overall mortality in the Marshall Islands. Specifically, the ban on shark finning, coupled with the high profile arrest and fine of a vessel for breaching this ban in the same year, would have made it more likely that vessels would release sharks alive rather than bringing them on board. In addition, research conducted by Ward et al. (2008) has shown that switching from wire trace to nylon substantially reduced shark bycatch in the pelagic longline fishery off northeastern Australia as the animals were able to bite through the lines to escape; it can be assumed that the introduction of the ban on wire trace would have had the same effect in BIOT. However a more detailed standardisation and analysis of CPUE and other environmental and physical factors is needed to properly explore if there are other additional reasons for this decline.

This analysis revealed a wide range of shark bycatch rates between vessels, although it was not possible with the available data to attribute this to a particular gear type or fishing technique. Interviews with vessel masters in BIOT revealed that the majority of sharks were caught on hooks closest to and on either side of the buoys (where the hooks are shallowest). They reported that the optimum depth range for targeting bigeye tuna is between 150m and 180m and that on shallower sets they will catch yellowfin tuna and sharks, this is shown in the data from the slight negative correlation between shark and bigeye tuna catches and positive correlation between shark and yellowfin tuna catches.

Table 2 Shark bycatch by proportion and CPUE. Data taken from WPEB reports.

Area	Species	Proportion	CPUE	Source
BIOT	Sharks (observer data)	4%	3.60 fish / 1,000hks	BIOT observer and longline data.
	Sharks (logbook data)	11%	1.16 fish / 1,000hks 34.58 kg / 1,000hks	
Madagascar	Mako shark	12%	143.00 kg/1,000hks	Rahombanjanahary, 2013
	Blue shark	1%	13.60 kg/1,000hks	
Thailand	Sharks by weight	4.64%	0.50 fish/1,000hks	Luesrithawornsin & Wongkeaw 2013
	Sharks by number	3.94%	17.10 kg / 1,000hks	
Reunion pelagic longline fishery (2009-2011)	Sharks		2.80 – 8.60 fish / 1000hks	Bach et al., 2012
	Blue shark	71% (of shark by-catch)		
Reunion pelagic longline fishery (1994-2000)	Blue shark	Up to 88% (of shark by-catch)	1.03 – 2.21 fish / 1000hks (small boats) 0.38 – 0.68 fish / 1000hks (large boats)	Poisson, 2007
	Oceanic whitetip		0.60 – 0.16 fish / 1000hks (small boats) 0.07 – 0.13 fish / 1000hks (large boats)	
East Indian Ocean	Sharks and rays	9.3% of catches		Chaidee & Darumas, 2011.
Japanese southern bluefin fishery	Sharks		0.268 fish per 1000hks	Okamoto et al. 2006
India	Sharks	20.83% by number 23.36% by weight		Varghese et al., 2007

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