ASSESSING SHARK AND RAY BYCATCH IN INDONESIAN DEEPWATER SNAPPER-GROUPER FISHERIES

Report on data analysis

January 2017 - December 2018

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by

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1. BACKGROUND AND OBJECTIVES

The purpose of this work is to assess shark and ray bycatch in Indonesian deep-water snapper and grouper fisheries. Since 2014, The Nature Conservancy (TNC) has been working with a number of Indonesian deep-slope (50-500 m) dropline and demersal longline fisheries that target various snapper, grouper and emperorfish species. These fisheries are currently being monitored using a Crew-Operated Data Recording System (CODRS) which provides photographs of all target and non-target catch. This monitoring program is organized through TNC's Indonesia field office to support the development and adoption of data-poor stock assessment approaches with involvement of the private sector in data collection.

Following the application of CODRS, TNC has gained information not only on the snapper, grouper, and emperorfish fishery but also its shark and ray bycatch. Globally, one quarter of all shark and ray species are currently threatened with extinction mainly due to their capture in target fisheries and as bycatch in other fisheries. In the last decade, government and non-government organizations have widely adopted conservation efforts to restore threatened shark populations, but these efforts are often hindered by a lack of comprehensive and accurate data.

This report assesses shark and ray bycatch through the development of a species list (according to species-level identification of the catch based on photographs that the crew take aboard fishing vessels). Here we provide a summary of the data and recommendations for monitoring the bycatch of sharks and rays in TNC's Crew-Operated Data Recording System (CODRS). This work is a continuation of a previous contract that was completed by Vanessa Jaiteh in February 2017, titled "Assessing shark and ray bycatch in Indonesian deepwater snapper-grouper fisheries".

This final report covers the analysis photographs of sharks and rays from January 2017 to December 2018. This includes a list of shark species identified (provided in an attached MS Excel spreadsheet), a summary of the catch composition and recommendations for monitoring.

2. CODRS IMAGE ANALYSIS: SUMMARY AND CATCH COMPOSITION

IMAGES ANALYSED

Images of the CODRS images were uploaded by TNC Indonesia to a Google Drive folder for analysis. These images were arranged in folders by year and month. During this project, images were analysed from the folders 2017_January through to 2018_Decemeber. This represents data from 1446 CODRS images.

A previous report prepared by V. Jaiteh in February 2017, “Assessing shark and ray bycatch in Indonesian deepwater snapper-grouper fisheries”, covers the analysis of sharks and rays photographed between 17th October 2015 and 29th October 2016. We did not find any images uploaded in November and December 2016. The data report herein therefore covers the period from the 1st January 2017 through to 31st December 2018.

Data collection in the months of January through to June 2017, were limited with only 7 images (25 sharks) over these 6 months. However, from July 2017 onwards, reporting was improved with at least 17 images (50+ sharks) per month.

For image analysis in this contract, we used the software Adobe Lightroom. This software provides an easy way to catalog all the images, as well as copy metadata (filename, time and date) from each image. For each image we copy the image name and time stamp into the excel spreadsheet, to facilitate later cross-checking of identifications and images analysed. For the majority of images, the metadata matched the file naming and the folders the images were placed in. The main descrepancies were images in the 2018_October, 2018_November, 2018_December folders when the metadata suggests the images were taken in January 2016. We did not analyse data using any of the date information, so does not change any results presented here. But it may be evident how the images are sorted in the attached excel file “CODRS Shark Bycatch 2017-2018.xlsx.”

For all images identified, we also used Adobe Lightroom to create a keyword list from all the shark species names grouped by family. This enables an easy way to cross-check an image with previously identified sharks and in the case of potentially misidentified sharks, all images can be sorted by species to check previous identifications.

From the 1446 images analysed here there were a total of 3172 sharks identified. The average number of sharks per image is 2.19 individuals. Although not all images contained sharks and some sharks were photographed multiple times.

SUMMARY OF CATCH BY FISHING PORT

Images were analysed from thirteen fishing ports throughout Indonesia. However, of these, only vessels from five ports (Galesong, Balikpapan, Kasuari, Lamongan and Probolinggo) photographed over 100 sharks over the two-year period (Table 1). From the data provided, we cannot be sure if the lower number of sharks photographed from other ports represents less fishing effort, less sharks caught, or if not all of the sharks were photographed.

Table 1: Number of sharks counted from vessels operating out of the different fishing ports.

PORT	NUMBER
Galesong	1589
Balikpapan	929
Kasuari	213
Lamongan	123
Probolinggo	106
Sape	51
Karang Serang	48
Saumlaki	17
Sumenep	16
Dobo	15
Sumbawa	13
Kema	12
Fakfak	8
Langkat	8
Mutiara Bahari	7
Aceh Barat	6
Sorong	5
Tual	3
Sangatta	2
Bontang	1
Grand Total	3172

SPECIES COMPOSITION

Of the 3172 sharks recorded to date, at least 64 species from 20 families were identified (Table 2). Some families, particularly Triakidae (Houndsharks) and Rhinobatidae (Guitarfishes), had several species that we could not confidently assign to a known species. Overall, we assigned 70 different taxa groups, but some we could only group as "spp." which we used when either the image was not good enough to identify the species and may represent one of the previously identified species, or it may also represent a different, unknown species. Less than 5% (149 sharks) we could not confidently assign to a known species.

Table 2. List of shark and ray species recorded from CODRS images between January 2017 and December 2018. The IUCN Red List of Threatened Species categories are as follows; DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR: Critically Endangered, N/A: Not available in IUCN Red List

FAMILY	TAXA	COMMON NAME	NUMBER	IUCN
Alopiidae	*Alopias pelagicus*	Pelagic thresher	1	VU
Carcharhinidae	*Carcharhinus albimarginatus*	Silvertip shark	16	VU
	Carcharhinus altimus	Bignose shark	2	DD
	Carcharhinus amblyrhynchoides	Graceful shark	6	NT
	Carcharhinus amblyrhynchos	Grey reef shark	60	NT
	Carcharhinus amboinensis	Pigeye shark	4	DD
	Carcharhinus brevipinna	Spinner shark	87	DD
	Carcharhinus falciformis	Silky shark	8	VU
	Carcharhinus leucas	Bull shark	3	NT
	Carcharhinus limbatus	Common blacktip shark	92	NT
	Carcharhinus macloti	Hardnose shark	34	NT
	Carcharhinus melanopterus	Blacktip reef shark	4	NT
	Carcharhinus plumbeus	Sandbar shark	4	VU
	Carcharhinus sealei	Blackspot shark	679	NT
	Carcharhinus sorrah	Spot-tail shark	321	NT
	Carcharhinus tjutjot	Indonesian whaler shark	68	VU
	Carcharhinus spp.		30	
	Galeocerdo cuvier	Tiger shark	75	NT
	Loxodon macrorhinus	Sliteye shark	272	LC
	Rhizoprionodon acutus	Milk shark	9	LC
	Rhizoprionodon oligolinx	Grey sharpnose shark	120	LC
	Triaenodon obesus	Whitetip reef shark	67	NT
Centrophoridae	*Centrophorus granulosus*	Gulper shark	1	NT
	Centrophorus moluccensis	Smallfin gulper shark	12	DD
Chimaeridae	*Chimaera argiloba*	Whitefin chimarea	3	LC
Dasyatidae	*Himantura jenkinsii*	Jenkins whipray	1	VU
	Maculabatis gerrardi	Whitespotted whipray	1	VU
	Maculabatis macrura	Sharpnose whipray	2	NE
	Neotrygon orientalis	Oriental bluespotted maskray	6	NE
	Neotrygon spp.		3	
	Pateobatis jenkinsii	Jenkins whipray	1	VU
	Taeniura lymma	Bluespotted fantail ray	1	NT
	Taeniurops meyeni	Blotched stingray	4	VU
Ginglymostomatidae	*Nebrius ferrugineus*	Tawny nurse shark	2	VU

Glaucostegidae	*Glaucostegus typus*	Giant guitarfish	1	CR
Hemigaleidae	*Chaenogaleus macrostoma*	Hooktooth shark	1	VU
	Hemigaleus microstoma	Sicklefin weasel shark	12	VU
	Hemipristis elongata	Fossil shark	11	VU
	Paragaleus randalli	Slender weasel shark	64	NT
Hemiscylliidae	*Chiloscyllium plagiosum*	Whitespotted bambooshark	2	NT
	Chiloscyllium punctatum	Brownbanded bambooshark	454	NT
Heterodontidae	*Heterodontus zebra*	Zebra hornshark	4	LC
Hexanchidae	*Hexanchus nakamurai*	Bigeye sixgill shark	5	DD
	Hexanchus spp.		1	
Orectolobidae	*Orectolobus leptolineatus*	Indonesian wobbegong	35	NE
Rhinidae	*Rhina ancylostoma*	Shark ray	5	CR
	Rhynchobatus australiae	Bottlenose wedgefish	73	CR
	Rhynchobatus springeri	Broadnose wedgefish	8	CR
Rhinobatidae	*Rhinobatos jimbaranensis*	Jimbaran guitarfish	2	VU
	Rhinobatos sp. 1		4	
	Rhinobatos sp. 2		2	
	Rhinobatos spp.		2	
Rhinopteridae	*Rhinoptera marginata*	Lusitanian cownose ray	1	NT
Scyliorhinidae	*Atelomycterus marmoratus*	Coral catshark	62	NT
	Cephaloscyllium pictum	Painted Swellshark	2	NE
	Halaelurus maculosus	Indonesian speckled catshark	1	LC
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead	226	EN
	Sphyrna mokarran	Great hammerhead	2	EN
Squalidae	*Squalus edmundsi*	Edmunds' spurdog	3	NT
	Squalus hemipinnis	Indonesian shortsnout spurdog	50	NT
	Squalus montalbani	Indonesian greeneye spurdog	6	VU
	Squalus nasutus	Western longnose spurdog	7	NT
	Squalus spp.		3	
Stegostomatidae	*Stegostoma fasciatum*	Zebra shark	6	EN
Triakidae	*Hemitriakis indroyonoi*	Indonesian houndshark	32	NE
	Mustelus sp. 1		36	
	Mustelus spp.		8	
	Triakidae sp. 1		18	
	Triakidae sp. 2		2	
	Triakidae spp.		22	
Grand Total			3172	

The majority of individuals were requiem sharks (family Carcharhinidae; 62% of all sharks recorded). The top fifteen shark species recorded are presented in Table 3. The most commonly recorded shark was the blackspot shark *Carcharhinus sealei*, followed by the brownbanded bambooshark *Chiloscyllium punctatum* and the spot-tail shark *Carcharhinus sorrah.* The scalloped hammerhead shark *Sphyrna lewini* was the 5th most commonly landed shark; this species is listed as endangered on the IUCN Red List of Threatened Species.

Table 3. The top fifteen shark species recorded with their number and IUCN Red List of Threatened Species categories; DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR: Critically Endangered.

TAXA	COMMON NAME	NUMBER	IUCN
Carcharhinus sealei	Blackspot shark	679	NT
Chiloscyllium punctatum	Brownbanded bambooshark	454	NT
Carcharhinus sorrah	Spot-tail shark	321	NT
Loxodon macrorhinus	Sliteye shark	272	LC
Sphyrna lewini	Scalloped hammerhead	226	EN
Rhizoprionodon oligolinx	Grey sharpnose shark	120	LC
Carcharhinus limbatus	Common blacktip shark	92	NT
Carcharhinus brevipinna	Spinner shark	87	DD
Galeocerdo cuvier	Tiger shark	75	NT
Rhynchobatus australiae	Bottlenose wedgefish	73	CR
Carcharhinus tjutjot	Indonesian whaler shark	68	VU
Triaenodon obesus	Whitetip reef shark	67	NT
Paragaleus randalli	Slender weasel shark	64	NT
Atelomycterus marmoratus	Coral catshark	62	NT
Carcharhinus amblyrhynchos	Grey reef shark	60	NT

The majority of the sharks identified were from the IUCN Red List category of “near threated” (66%), whereas 15% were listed under the threatened categories of “vulnerable” (4%), “endangered” (8%) and critically endangered (3%) (Figure 1). The scalloped hammerhead *Sphyrna lewini* was the main species contributing to the endangered category. The wedgefishes (Rhinidae), primarily bottlenose wedgefishes *Rhynchobatus australiae,* were caught as bycatch with 86 individuals. These rays are listed as endangered and in August 2019 were adopted into Appendix II of the Convention on International Trade in Endangered Species (CITES). They join the hammerhead sharks (Sphyrnidae) under this listing which aims to ensure that international trade in these species does not threaten their survival.

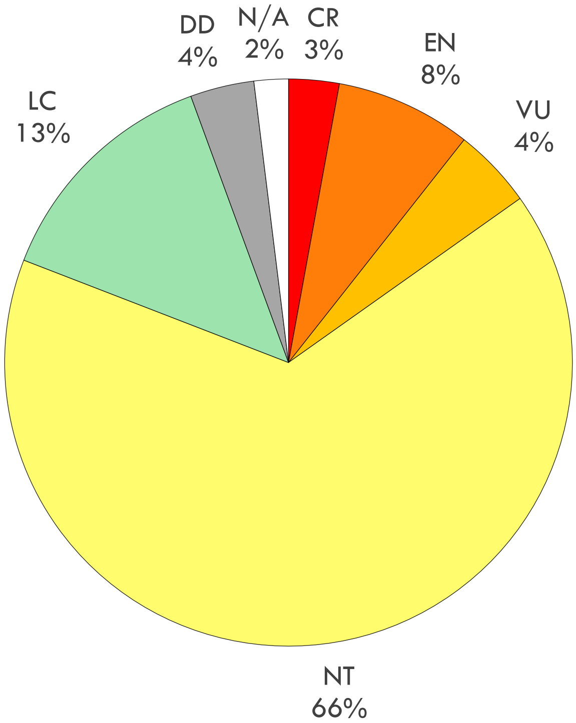

Figure 1. Pie chart showing the percentage of sharks within each IUCN Red List of Threatened Species categories; DD: Data Deficient, LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered, CR: Critically Endangered, N/A: Not available in IUCN Red List

LENGTH FREQUENCIES

Through the analysis of photographs, 96% of sharks could be given an estimated length. We estimated stretched total length (TL) from the tip of the snout to the tip of the top lobe of the caudal fin, and as most sharks were not fully stretched when placed on the measure board, we estimated what the TL would be if caudal fin was fully extended. Especially for lengths greater than 1 m, these lengths should be treated as an estimate, as the CODRS measure boards only extend to 80 or 100 cm and we crudely estimated lengths above that, whilst attempting to give lengths to all sharks where there was some scale to use. Despite the limitations, these measurements give a basic idea on the sizes of sharks landed.

For the top 16 species with =>50 individuals, we plotted the length frequencies along the known size at maturity (if available), either as both sexes combined, or males and or females. These values were taken from recent papers in PNG (Appleyard et al. 2018, White et al. 2019), the Indonesian market guidebook (White et al. 2006) and Rays of the World (Last et al. 2016), or the taxonomic papers describing the species, but these maturity values may not be exact for the given region.

The majority of sharks measured were small, with 87% equal than or less than 1 m in length. Even those that grow to a large size and reach maturity at lengths > 1.5 m, such as the scalloped hammerhead shark *Sphyrna* *lewini, Tiger Shark Galeocerdo cuvier*, common blacktip shark *Carcharhinus limbatus, and spinner sharks Carcharhinus brevipinna,* nearly all caught at sizes below their length at maturity.

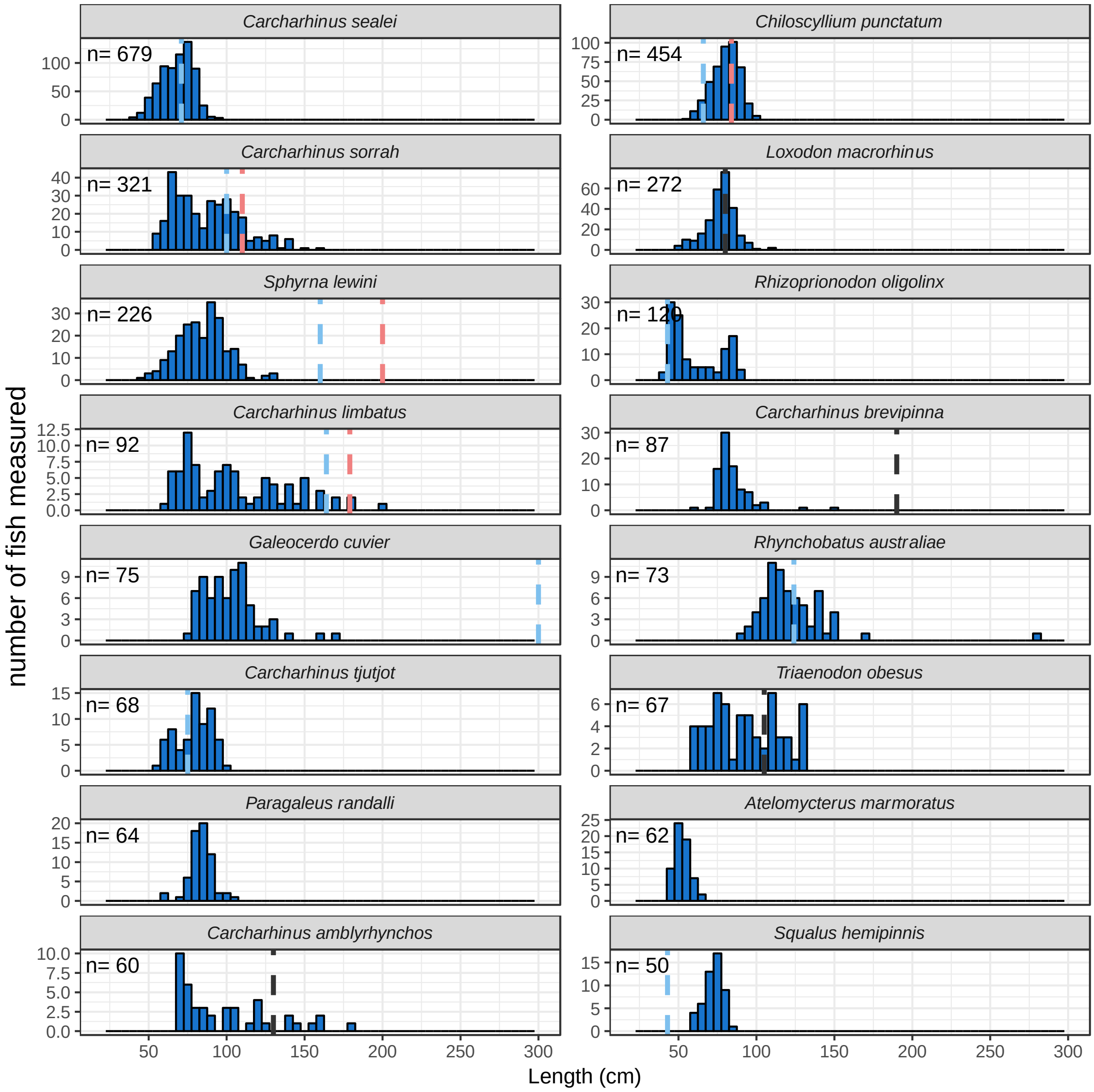

Figure 2. Length frequencies of the top 16 species of sharks photographed. Bin width is 5 cm and length represent stretched total length (cm), with sharks larger than 1 m we estimated the length from images. Length at maturity is indicated by dashed lines; both sexes combined (black), males (blue) and females (red).

NOTES ON IDENTIFICATIONS

There have been many changes in shark and ray taxonomy over the past decade, especially in Indonesia. These include some of the very common species recorded from this bycatch data, for example the slender weasel shark, *Paragaleus randalli* (White and Harris 2013) was previously assumed to be *P. tengi* in the species guidebook by White et. al (2006). The Indonesian whaler shark *C. tjutjot* (White, 2012) was originally regarded as *C. dussumieri* in White et al. (2006), but since then the name *C. tjutot* has been resurrected for the Indonesian specimens (White 2012). Many of the dogfishes (Squalidae) have received species names in 2007 (Last et al. 2007) but are still difficult to confidently identify from images. The main family we had trouble identifying were the houndsharks (Triakidae), and it has been suggested that there is a substantial amount of diversity in this genus that remains to be classified (Naylor et al 2012). We will attempt to resolve some of these identifications through the input from taxonomists and update this report.

The taxonomy of rays has also changed considerably in the past three years. The book Rays of the World by Last et al. (2016) provides the most recent species lists and changes in families and genera for many of the species recorded from Indonesian fisheries. We have followed the newest known taxonomic classifications from that book for this report. However, still some species are difficult to identify particularly the Guitarfishes (Rhinobatidae).

3. RECOMMENDATIONS FOR MONITORING SHARK AND RAY BYCATCH

PHOTOGRAPHING SHARKS AND RAYS

The images provided for this analysis were much improved from the previous analysis of 2016 data in the 2017 report. The majority of sharks were placed on the measure board and there were not many sharks that were seen on a vessel but not individually photographed, with the exception of some images from Kasuari port (Figure 3).

Figure 3. Example images showing catches of large sharks landed on a beach and some piled in the boat without being individually photographed

Although the vast majority of sharks were photographed whole, there were some instances of sharks with the fins removed before photographing (Figure 4). This obviously makes the identifications more difficult.

Figure 4. Two example images of fins removed before photographing the sharks

Having the sharks placed on the measure board greatly facilitated identification and length measurements. However, often several sharks were photographed together, with overlapping pectoral fins or other body parts, or they had their image taken from directly above. While we have become quite familiar with the identifying features of the majority of landed sharks, for more reliable and efficient analysis it would be preferable to have the photographs taken at an oblique angle and with fins not overlapping. Examples of good photographs that make it easy to see all the identifying features are provided below (Figure 5). Figure 6 shows examples of images that make identification more difficult, including top down and crowded images that obscure features such as dorsal and pectoral fin colour and shape, and the position of the ventral and anal fins in relation to the dorsal fins.

Figure 5. Good examples showing a fossil shark *Hemipristis elongata* (left) and *Carcharinus sealei* (right) with the camera on a slight angle so that all fins can be seen along with the presence of the interdorsal ridge.

Figure 6. Images that are not optimal. Top-down view of the sharks makes it difficult to identify features on the dorsal and caudal fins (left). It would be preferable to have the image on an oblique angle to the side to help see the colour and shape of dorsal fins and the relative position of the dorsal fins to the pectoral and anal fins. If there are too many sharks on the board (right), it covers their fins and makes it harder to positively identify.

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