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Short Communication

Elasmobranch capture by commercial small-scale fisheries in the Bijagós Archipelago, Guinea Bissau

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ABSTRACT

A standardised survey is used to investigate elasmobranch capture during commercial small-scale fishing operations in the Bijagós Archipelago (West Africa). Data refer to 211 landing episodes attributed to four main gears. Results show that elasmobranchs can constitute up to 10% of total capture. Five orders are identified and catch-per-unit-effort peaks for large-hook long-lines. The presence of both adult and neonate elasmobranch catch suggests fishing may occur inside nursery habitat.

1. Introduction

Elasmobranchs (sharks, skates, rays and guitarfishes) show certain 'slow' life history traits (Dulvy et al., 2008; Dulvy and Forrest, 2010) which coupled with their high monetary value, has contributed to the 'threatened' status of many species (Fowler et al., 2009). In particular, they rely upon shallow coastal waters as pre and post-natal nursery areas, where fishing also proliferates (Lucifora et al., 2011; Dulvy et al., 2014). In this work, elasmobranch capture in West African small-scale commercial fishing gear is evaluated. This can occur through either targeted or incidental practices, but is commonly rewarded by financial incentives to supply a Far-Eastern market no longer able to support Asian demand (Clarke et al., 2004, 2007). With West African SSF landings at their lowest in twenty years (Belhabib et al., 2014) this investigation aims to supplement existing longer-term data in a region where both fisher-migrations and elasmobranch capture are synonymous with financial gain (Diop and Dossa, 2011).

2. Materials and methods

In the UNESCO held Bijagós Archipelago, regional in-migrants have managed and controlled commercial SSF operations out of seasonal settlements or fishing camp enclaves, for several decades (Campredon and Cuq, 2001; Binet et al., 2012; Cross, 2015). They include fishers, processors and traders who transform the catch through sun-drying, smoking and salting before transhipment to numerous mainland markets. A specific tendency for Senegalese Nhyominka fishers, to focus on sharks and rays has been described (Dulvy et al., 2008). Between 2009 and 2010 twenty-eight elasmobranch species were documented in Guinea-Bissau (Jung et al., 2011); yet despite the regions diversity, the 'critically endangered' sawfishes continue to receive greatest attention (Robillard and Séret, 2006; Leeney and Poncelot, 2013). Most recent sawfish sightings have now been dated back to the 1980s and more contemporary studies link their demise with a growth in commercial SSF (Leeney and Poncelot, 2013). The indigenous occupants of the archipelago (Bijagós Islanders) are subsistence agriculturalists rather than fishers (Haakonsen, 1991; Tvedten, 1990; Baekgaard and Overballe, 1992). Their animistic beliefs; reverence of spirits (imbued within natural phenomena) and the age-structured socio-cultural system which governs their secret initiation process, have all been used to highlight a 'cultural connection' with their environment (Robillard and Séret, 2006). Many areas across the archipelago are locally sacred and attempts are made to restrict fishing at certain times. The islands therefore provide an interesting case, for not only investigating elasmobranch capture but also understanding more 'traditional' ways of managing fishing effort.

A SSF camp on Uno Island (Fig. 1) was visited regularly between 2008 and 2010. This site was purposefully chosen on account of proximity and trade, between the camp and neighbouring Bijagó villages. This facilitated a cross-cultural livelihood analysis (Cross, 2014). A landing-survey documenting the temporal and physical specifics of fish capture: including date and time of landing; gear-type; gear duration inside the water; fishing ground; habitat-type and commercial catch quantities was devised for the purpose of

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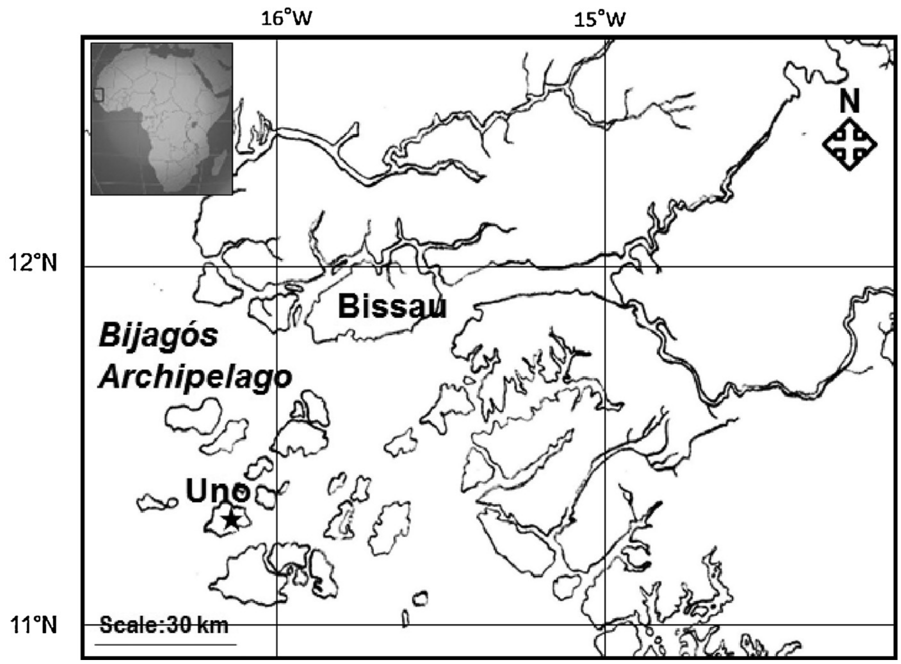

Fig. 1. (Insert) Location of Guinea-Bissau on the West African Coast; (Main Map) Location of the capital city Bissau, the offshore Bijagós Archipelago and study-site Uno Island.

this study. Data presented here refer to four main gears; fine-mesh monofilament nets (P-MN), gillnets (GN), small-hook (SH-LL) and large-hook (LH-LL) longlines (Table 1). The definitions of catch per unit effort (CPUE) are gear-specific, referring to '*kilograms of fish/per 1000 m^2 net area/tide*' (for the P-MN and GN) and '*kilograms of fish/per 1000 hooks/tide*' (for both SH and LH longlines). Landed fish were separated inside the camp into major groups including bonga-shad (*Ethmalosa fimbriata*), sea catfish (*Arius* spp.), croakers (*Pseudutolithus* spp.), elasmobranchs and other miscellaneous fish (such as mackerel, snapper, jack and grunt). These groups are distinguished in the analysis. Given the commercial nature of the SSF operations on Uno, landing survey data-collection was designed to have minimal disruption. As a result, four caveats are observed. Firstly, landings of bonga, catfish and other miscellaneous fish (all smoked produce) were measured in 'pans'; a generic term describing metal fish-carrying containers. One pan of either bonga or other miscellaneous fish was said to weigh 10 kg; in contrast, one pan of catfish held 12 kg. Given that it was not possible to weigh every pan at landing, the surveys instead summarise catch in terms of pan measures and then convert these to kilogram equivalents. Secondly, elasmobranchs were identified as possible using the Eastern Tropical Atlantic identification guide (Séret, 2006). However, sub-adult sharks are notoriously difficult to identify (Beerkircher et al., 2002) and accurate identification usually necessitates dissection, particularly of the head or jaw (Séret pers. Comm. 2009). Given the commercial nature of fishing, dissection was not possible and elasmobranch landings are here differentiated into three broad groups: skates/rays, sharks and guitarfishes. Thirdly in only very few instances, have specimens of elasmobranch been measured. A total length (TL) measure (linear distance from the tip of the snout to the distal edge of the longer pelvic fin) was used for the sharks. A disc width (DW) measure (linear distance across the widest portion of the disc) has been used for skate, rays and guitarfishes (Bizzarro et al., 2007). Finally, the surveys exclude any landing events made following multiple-day fishing trips (known as 'campaigns'). These trips were usually undertaken by motorised gillnet fishers who described setting and hauling numerous sets of gear in various fishing locations across the archipelago. Factorial ANOVA tests (IBM SPSS Version 21) have been used to investigate variation in elasmobranch CPUE between gear-types. Tests are also performed for gear selectivity on individual elasmobranch weight and size metrics.

Table 1
Gear dimensions and characteristics of the four gear-types.

Description	Nets		Lines	
Gear name	Monofilament net (paddle-powered)	Gill-net	Long-line (small-hook)	Long-line (large-hook)
Abbreviation	P-MN	GN	SH-LL	LH-LL
Crew size	2–3	2–3	2–3	2–3
Position in water column	Pelagic (near-surface)	Mid-Water	Demersal (deep water)	
Gear operating strategy	Nets set straight; 1–2 sets per trip (more during rainy season); sets left for 6 h (max) before haul	Nets set straight; 1 set per trip; sets left for up to 8 days before haul	Lines set straight; up to 4 sets per trip (more during dry season); sets left for up to 2 days before haul	
Number of nets	30	2–10	–	–
Size of mesh/or hook	28–32 mm	240 mm	Hook size: 7,8 (3–4 cm)	Hook size: 3,4,5 (5–7 cm)
Average gear area/number of hooks	500–2500 m^2	450–4500 m^2	1200–2000	450–1100
Engine power (HP)	–	6/8/40	6/15	8/15

Table 2
Details of landing episodes by gear-type.

Gear	Nets		Lines		Total
	P-MN	GN	SH-LL	LH-LL	
No. of landings (dry)	36	33	20	8	97
No. of landings (rain)	66	23	10	5	104
No. of landings (total)	102	56	30	13	211
Catch dry (kg)	1644.75	1235.25	1332.25	372.75	4585.0
Catch rain (kg)	2930.5	925.9	457.00	316.00	4629.4
Total catch (kg)	4575.25	2161.15	1789.25	688.75	9214.4

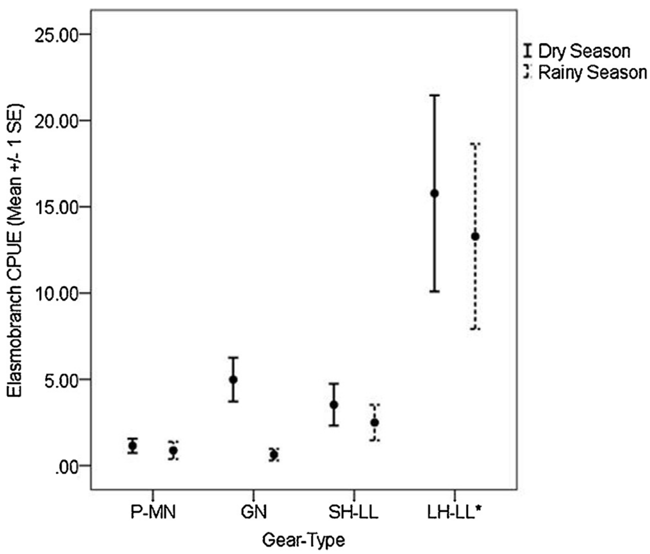

Fig. 2. Elasmobranch CPUE for the four gears.

3. Results and discussion

In total 211 fish landing episodes (or 9214.4 kg of capture) have been documented from Uno for four gear types (Table 2). Catch comprises bonga-shad (57%); catfish (13%), croaker (11%), elasmobranch (10%) and other miscellaneous fish (8%). Elasmobranchs are encountered during the majority (75%) of excursions to fish and five orders are identified (*Carcharhiniformes*, *Orectolobiformes*, *Squaliformes*, *Rajiformes* and *Torpediniformes*). In total, 1395 kg (wet-weight) of elasmobranchs are documented with 41% of this, taken by GNs. Elasmobranch CPUE peaks during both seasons with the LH-LL (Fig. 2). Skate and ray captures include spiny butterfly rays (*Gymnura altavela*) of DW 30–44 cm; common stingrays (*Dasyatis pastinaca*) of DW 108–130 cm; and daisy stingrays (*Dasyatis margarita*) of DW 15–28 cm. The common guitarfish (*Rhinobatus rhinobatus*) is observed of DW 18–72 cm and equivalent weight range of 3.5–59.5 kg; and the black-chin guitarfish (*Rhinobatus cemiculus*) also identified. LH-LLs are seen to catch the greatest number of skate/ray specimens and proportionally more guitarfishes (by wet weight) than all other gears. Finally, SH-LLs capture the lightest and GNs the heaviest shark specimens (*Kruskal Wallis: Chi Square* = 13.0, $df = 3$, $p = 0.005$).

The IUCN declares 21% of all known shark species to be 'threatened', 5% 'endangered' and 13% 'vulnerable' (Dulvy and Forrest, 2010). Perhaps more importantly however, 34% of elasmobranch species are considered 'data deficient' such that in most places, they are a common but unspecified component in many fishing operations (Camhi et al., 2009). In this study, critically endangered (*G. altavela*), endangered (*D. margarita*, *R. rhinobatus*, *R. cemiculus*) and data deficient (*D. pastinaca*) elasmobranch species are identified in coastal fishing grounds around Uno Island. Furthermore, both neonate and fully mature individuals are recognised. This could represent fishing gear bias, or be indicative of a nursery area (Carr et al., 2013). Many coastal elasmobranchs use bays, estuaries and shallow, near-shore waters as pupping and nursery areas where abundant small fishes and shrimp provide food (Castro, 1993; Belcher and Jennings, 2011). The fishing grounds around Uno certainly fit this description. These findings convey that elasmobranchs in near-shore coastal waters around the Bijagós islands are susceptible to commercial SSF capture. This study therefore supports the need for monitoring and research to inform the development of novel elasmobranch-focussed fisheries management strategies (Doherty et al., 2014; Dulvy et al., 2014).

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References

Baekgaard, M., Overballe, H., 1992. When is a fishing man a fisherman? Artisanal fishery development in Guinea Bissau. In: Tvedten, I., Hersoug, B. (Eds.), Fishing for Development Nordiska Afrikainstitutet. The Scandinavian Institute of African Studies.

Beerkircher, L.R., Cortes, E., Shivji, M., 2002. Characteristics of shark bycatch observed on pelagic longlines off the southeastern United States, 1992–2000. Mar. Fish. Rev. 64 (4), 40–49.

Belcher, C.N., Jennings, C.A., 2011. Identification and evaluation of shark bycatch in Georgia's commercial shrimp trawl fishery with implications for management. Fish. Manag. Ecol. 18, 104–112.

Belhabib, D., Koutob, V., Sall, A., Lam, V.W.Y., Pauly, D., 2014. Fisheries catch misreporting and its implications: the case of Senegal. Fish. Res. 151, 1–11.

Binet, T., Failler, P., Thorpe, A., 2012. Migration of Senegalese fishers: a case for regional approach to management. Marit. Stud. 11, 1–15.

Bizzarro, J.J., Smith, W.D., Marquez-Farias, J.F., Heuter, R.E., 2007. Artisanal fisheries and reproductive biology of the golden cownose ray. *Rhinoptera steindachneri* (Evermann and Jenkins, 1891) in the northern Mexican Pacific. Fish. Res. 84, 137–146.

Camhi, M.D., Valenti, S.V., Fordham, S.V., Fowler, S., Gibson, C., 2009. The Conservation Status of Pelagic Sharks and Rays. Report of the IUCN Shark Specialist Group Pelagic Shark Red List Workshop, IUCN Species Survival Commission Shark Specialist Group Newbury, UK, x + 78 p.

Campredon, P., Cuq, F., 2001. Artisanal fishing and coastal conservation in West Africa. J. Coast. Conserv. 7, 91–100.

Carr, L.A., Stier, A.C., Fietz, K., Montero, I., Gallagher, J.A., Bruno, J.F., 2013. Illegal shark fishing in the Galapagos marine reserve. Mar. Policy 39, 317–321.

Castro, J.I., 1993. The shark nursery of Bull's Bay, South Carolina, with a review of the shark nurseries of the south-western coast of the United States. Environ. Biol. Fish. 38, 37–48.

Clarke, S., Milner-Gulland, E.J., Bjorndal, T., 2007. Perspectives: social, economic and regulatory drivers of the shark fin trade. Mar. Resour. Econ. 22, 305–327.

Clarke, S.C., McAllister, M.K., Michielsens, C.G.J., 2004. Estimates of shark species composition and numbers associated with the shark fin trade based on Hong Kong auction data. J. Northwest Atl. Fish. Assoc. 35, 453–465.

Cross, H., 2015. Why fish? Using entry-strategies to inform governance of the small-scale sector: a case-study in the Bijagós Archipelago (West Africa). Mar. Policy 51, 128–135.

Cross, H.C., (Unpublished Ph.D. thesis) 2014. The Importance of Small-Scale Fishing to Rural Coastal Livelihoods: A Comparative Case-Study in the Bijagós Archipelago, Guinea Bissau. Department of Anthropology, University College London.

Diop, M., Dossa, J., 2011. 30 Years of Shark Fishing in West Africa Development of Fisheries, Catch Trends, and their Conservation Status in Sub-Regional Fishing Commission Member Countries. FIBA Publications.

Doherty, P.D., Alfaro-Shigueto, J., Hodgson, D.J., Mangel, J.C., Witt, M.J., Godley, B.J., 2014. Big catch, little sharks: insight into Peruvian small-scale longline fisheries. Ecol. Evol. 4 (12), 2375–2383.

Dulvy, N.K., Fowler, S.L., Musick, J.A., Cavanagh, R.D., Kyne, P.M., Harrison, L.R., Carlson, J.K., Davidson, L.N.K., Fordham, S.J., Francis, M.P., Pollock, C.M., Simpfendorfer, C.A., Burgess, G.H., Carpenter, K.E., Compagno, L.G.V., Ebert, D.A., Gibson, C., Heupel, M.R., Livingstone, S.R., Sanciangco, J.C., Stevens, J.D., Valenti, S., White, W.T., 2014. Extinction risk and conservation of the world's sharks and rays. eLife 3, http://dx.doi.org/10.7554/eLife.00590

Dulvy, N.K., Forrest, R.E., 2010. Chapter 17: Life histories, population dynamics, and extinction risks. In: Carrier, J.C., Musick, J.A., Heithaus, M.R. (Eds.), Chondrichthyans. Sharks and their Relatives II: Biodiversity, Adaptive Physiology, and Conservation. , 1st ed. CRC Press Taylor and Francis Group, pp. 635–667.

Dulvy, N.K., Baum, J.A., Compagno, I.J.V., Cortés, E., Domingo, A., Fordham, S., Fowler, S., Francis, M.P., Gibson, C., 2008. You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. Aquat. Conserv.: Mar. Freshw. Ecosyst. 18, 459–482.

Fowler, S., Camhi, M., Fordham, S.V., Valenti, S.V., Gibson, C., 2009. The Conservation Status of Pelagic Sharks and Rays: A Report of the IUCN Shark Specialist Group Pelagic Shark Red List. IUCN Species Survival Commission (SSC), Shark Specialist Group.

Haakonsen, J.M., 1991. The role of migrating fishermen in West Africa: what we know and what we still need to learn. In: Dura, J.R., Lemoalle, J., Weber, J. (Eds.), ORSTOM-IFREMER Montpellier, France, 3–7 juillet l989. , pp. 709–715.

Jung, A., Bucal, D., Gomes, M., 2011. Mission de renforcement des capacités du CIPA/PAN-Requins pour le traitement et l'analyse des enquêtes 2009–2010. Rapport de Synthèse, Noé Conservation.

Leeney, R.H., Poncelot, P., 2013. Using Fishers' Ecological Knowledge to Assess the Status and Cultural Importance of Sawfish in Guinea-Bissau. Aquatic Conservation: Marine and Freshwater Systems, http://dx.doi.org/10.1002/aqc.2419

Lucifora, L.O., Garcia, V.B., Worm, B., 2011. Global biodiversity hotspots and conservation priorities for sharks. PLoS ONE 6 (5), e19356.

Robillard, M., Séret, B., 2006. Cultural importance and decline of sawfish (Pristidae) populations in West Africa Cybium 30 (Suppl.), 23–30.

Séret, B., 2006. Identification Guide of the Main Shark and Ray Species of the Eastern Tropical Atlantic, for the Purpose of the Fishery Observers and Biologists. IRD and MNHN.

Tvedten, I., 1990. The difficult transition from subsistence to commercial fishing: the case of the Bijagós of Guinea Bissau. MAST 3, 119–130.