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Guinean landing surveys of Bentfin devil rays add insight into threatened elasmobranch catch

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Abstract Populations of many elasmobranchs have decreased globally, with over a third of species threatened with an elevated risk of extinction, largely due to fishing pressure. In West Africa, a general lack of species-specific catch data limits the ability to implement effective management, despite significant elasmobranch catch. The aim of this study was to (1) assess landings of mobulid rays, along with other elasmobranch species, recorded opportunistically in fisheries from Guinean waters, (2) provide information on the value and trade of these species, and (3) discuss management implications. Elasmobranchs were photographed and identified during market surveys over a ten-month period in 2014 and 2015, at four local Guinean fish markets: Bonfi, Boulbinet, Kassa, and Kamsar. A total of 1954 specimens, comprising 17 different elasmobranch species, were recorded across all markets. Of these species, 94% are assessed as threatened (vulnerable, endangered, critically endangered) and 6% are assessed as Near Threatened on the IUCN's Red List of Threatened Species. The only mobulid species recorded was *Mobula thurstoni*, with significantly larger specimens recorded in Boulbinet, while in Bonfi fishing grounds overlapped with young-of-the-year specimens. When considering all elasmobranch landings, Bonfi and Boulbinet had similar species compositions, although when considering daily data, species composition tended to differ. Indicator Species Analysis indicated that *Carcharhinus falciformis*, *Carcharhinus leucas*, and *Mustelus mustelus* were top indicator species for Bonfi (with high specificity and fidelity), while *Paragaleus pectoralis* and *Gymnura sereti* were key indicator species for Boulbinet. Records of selling price at Bonfi were higher for various stingray species than larger shark species, suggesting meat as a primary driver of the fishery. This study adds insight into the species composition of elasmobranch catch in West Africa and highlights specific fishing sectors contributing to elasmobranch exploitation locally; information which is needed to understand the effects on regional stocks.

Keywords Mobula · Rays · Sharks · Species composition

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Introduction

Populations of many elasmobranchs (sharks and rays) are declining worldwide (Dulvy et al. 2014), fueling much-needed research and management for these species (Simpfendorfer et al. 2011; Costello et al. 2012). There are many reasons leading to the declines in populations, with fishing pressure identified as the primary cause (Simpfendorfer and Dulvy 2017), both from direct fisheries and incidental catch in other fisheries (Dulvy et al. 2021). Targeted and retained incidental catch of elasmobranchs is driven by demand for a range of consumable products, such as meat, fins, and gill plates (Dulvy et al. 2017). Global demand for shark fins and mobulid (manta and devil rays) gill plates stems primarily from East and Southeast Asia (Vannuccini 1999; Fabinyi and Liu 2014; Palacios et al. 2025). Shark and ray meat is also an important driver of fisheries, especially in areas with high levels of poverty, where it is used as a source of low-cost animal protein (Dent and Clarke 2015; Dulvy et al. 2017). The fishing pressure has resulted in 37% of worldwide elasmobranch species likely threatened with extinction (Dulvy et al. 2021). This growing awareness of population declines has led to increased management measures through multilateral environmental agreements, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS), as well as regional and national fisheries management, over the last two decades. Management of elasmobranch fisheries has been successful in some areas throughout the world (Tribuzio et al. 2011; Grubert et al. 2013; Braccini et al. 2014); however, it is largely limited to developed nations (Simpfendorfer and Dulvy 2017). Direct fisheries management efforts in developing nations are limited and have often been restricted to wider regional agreements, such as Regional Fisheries Management Organizations (RFMO), which are rarely implemented (Pacoureau et al. 2023). Very few countries have introduced national restrictions on shark and ray capture, and even fewer have adequate implementation of such measures (Dulvy et al. 2017). Developing nations face larger hurdles when attempting elasmobranch management due to strong demand for low-cost protein for food security, in addition to the economic benefits for coastal populations (Booth et al. 2019). There is limited data currently available for many elasmobranch fishing hotspots (Baum et al. 2003; Osgood and Baum 2015), especially species-specific landings data in developing nations (Baum et al. 2003; Simpfendorfer and Dulvy 2017), as is the case off the coast of Central and West Africa (Jabado et al. 2024).

West Africa is a developing region spanning Mauritania to Nigeria, including a total of 17 nations (14 of which are coastal). Fishing has a large economic and subsistence value throughout the region, which has resulted in a fully exploited marine environment (Belhabib et al. 2013). There are three main types of fishing in West Africa's Exclusive Economic Zones (EEZ): small-scale fisheries, domestic industrial fisheries, and foreign fleet fisheries. With no limits on fleet size (Diop and Dossa 2011), the number of small-scale boats has been steadily increasing and currently comprises a higher fishing effort than the industrial fisheries in West Africa (Belhabib et al. 2018). These fisheries operate in coastal waters and often overlap with areas of ecological importance for many shark and ray species, which rely on mangroves, seagrass meadows, rocky shores, and tidal flats as nursery grounds (Heupel et al. 2019; Leurs et al. 2021, 2025). A significant proportion of industrial fishing is undertaken by foreign fleets, specifically from Europe, China, Japan, Korea, Ghana, and Russia (Kroese and Sauer 1998; Alder and Sumaila 2004; Brashares et al. 2004). Their presence in West Africa is well documented (Alder and Sumaila 2004); however, levels of illegal, unreported, and unregulated (IUU) fishing, catch composition, bycatch, and the overall impacts on resources are generally not well recorded in the region (Kaczynski and Fluharty 2002; Atta-Mills et al. 2004). Yet, evidence suggests that industrial fishing in the region, especially using trawls, drifting longlines, and fixed gear types, poses an important threat to elasmobranch species through high take rates (Leurs et al. 2021).

Estimates of elasmobranch landings for the region are available from the FAO (Dulvy et al. 2017) and The Sea Around Us project (SeaAroundUs.org). However, neither of these data sources provides detailed species-specific information on catches, limiting the ability to assess the status of species and stocks, or implement data-informed management measures. In an effort to obtain baseline data on elasmobranch fisheries in the region, a sub-regional action plan (Plan sous-régional d'action, PSRA) was put in place in West Africa by the Commission sous-régionale des pêches (CSRP) from 2004 to 2009, which included monitoring the coast of Guinea (Diop and Dossa 2011). However, there is still limited elasmobranch catch data available for many countries, including Guinea.

To help address this lack of information on elasmobranch catch composition in West Africa, this study had the following specific aims: (1) identify the mobulid species, along with other elasmobranchs recorded opportunistically in fisheries from Guinean waters, especially those of conservation concern, (2) provide information on the value and trade of these species, and (3) discuss management implications.

Methods

Study sites

Guinea is part of a dynamic aquatic ecosystem driven by warm temperatures and an abundance of light (Nieto and Mélin 2017). The cold Canary Current feeds south into the North Equatorial countercurrent and the warm Guinea current (Diop et al. 2014). Offshore wind is the main cause of cold water upwelling, which is prominent in this region (Diop et al. 2014). The coastal area running from Guinea-Bissau to Sierra Leone has a large amount of river runoff and high precipitation, which supplies the Guinean coast with warm, low salinity water (Diop et al. 2014). All of these factors supply the region with high nutrient-abundant waters along the Guinea coast (Djakouré et al. 2014; de Coëtlogon et al. 2023). Guinea has a large continental shelf (< 200 km) that provides an extended fishing habitat for both artisanal and industrial fisheries (Diallo 1996). The predominant coastal morphology is sandy bottoms, marshes, estuaries, and mangroves (Diop et al. 2014).

The two main markets sampled, Bonfi (9.555990, −13.636978) and Boulbinet (9.508947, −13.703643), are located around the capital, Conakry (Fig. 1). The two regional markets in this study were Kamsar (located on the border with Guinea-Bissau, 10.670626, −14.609638) and Kassa (located on an

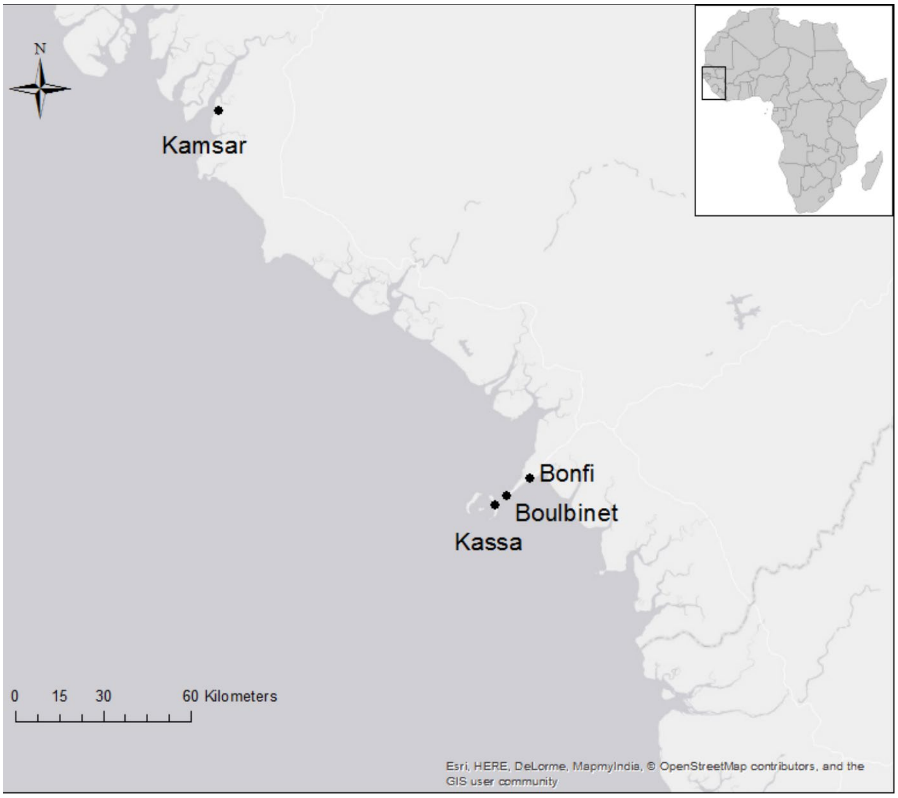

Fig. 1 Four fish markets sampled along the coast of Guinea. Bonfi and Boulbinet are located around the capital Conakry and Kassa is located on an island off of the capital. The fourth market, Kamsar, is located in the northern part of Guinea

island off Conakry, 9.477949, −13.747324) (Fig. 1). Although Bonfi and Boulbinet are in close proximity, they have different characteristics; Bonfi is the smaller, less developed market used primarily by small-scale fishers that operate approximately 140 boats (Fig. 2). Out of these, around 35 are reported to incidentally catch elasmobranchs on occasion. Boulbinet is the largest market in this study that serves both industrial (around 250 vessels) and small-scale fisheries. Fifty of these industrial boats report elasmobranch bycatch, and 3 to 5 vessels are thought to specialise in elasmobranch fishing (F. Doumbouya, unpublished data). No information was available on the number of boats that supply Kassa or Kamsar markets.

Data collection

Elasmobranch fish market surveys were conducted from October 2014 to June 2015. Boulbinet and Bonfi were sampled five times per month during the off-season (October to December), and ten times per month during the peak fishing season (January to June). A total of 81 monitoring days occurred at Bonfi and 86 days at Boulbinet. The two other markets were surveyed irregularly; Kamsar was surveyed five times during November and then abandoned due to a lack of elasmobranch landings recorded and the surveyor's far travel distance, while Kassa was surveyed once in December and five times in February. The total species-specific landings recorded by both small-scale fisheries as well as industrial fisheries over the study period within a given month were converted to the number of specimens landed per day and further multiplied by the number of days within the month to provide a projected monthly elasmobranch catch. Due to the fast-paced landings at these sites, we could not determine the exact landings per boat.

Elasmobranch specimens were photographed at each market at the time of landing, and species were identified using "A Pocket Guide to Sharks of the World" (Ebert 2015) and the "Field Guide to the Identification of Mobulid Rays" (Stevens 2012). Species identifications were later validated with the help of experts using the photographs. In cases of closely related species, key features, such as individuals'

Fig. 2 Photos taken at Bonfi and Boulbinet during the sampling period. **a** Sampling photo at Boulbinet with elasmobranch species *Glaucostegus cemiculus*, *Rhinobatos rhinobatos*, and *Taeniurops grabatus*. **b** *Rhizopronodon acutus* fin harvesting after landing at Bonfi. **c** *Sphyrna lewini* landings during one sampling day in the month of March at Boulbinet. **d** *Mobula thurstoni* landed by a Chinese fishing vessel in Boulbinet during April 2015

mouths, nostrils, rostrum, and fin shape were used to distinguish species. Numbers were estimated in photographs that contained large piles of sharks or rays, and as a result, species abundances were approximated. Species-specific catch at each market was then compiled and compared between markets.

Additional information, such as measurements, catch gear, and selling price, was taken at the time of landing at Bonfi and Boulbinet opportunistically based on interviews with fishers. Selling price was recorded for ten elasmobranch species landed during October and December (2014) at Bonfi. Market value relative to specimen size was further compared across species. Catch method and disc width (DW, the distance from pectoral fin tip to pectoral fin tip) for all mobulid rays (*Mobula* spp.) were recorded for each individual landed during the sampling period. Maturity of each mobulid ray was determined based on the approximate size of visible claspers.

To examine the level of threat faced by the species caught, the status of species on the IUCN's Red List of Threatened Species was obtained from www.iucnredlist.org. The Red List assessments used are global in scope; therefore, regional status may not match global status. CITES also lists species that are regulated from over-exploitation in international trade, and these listings were assessed for each species landed.

Statistical analysis

A Gaussian general linear model (GLM) was used to assess whether bentfin devil rays (*Mobula thurstoni;* Lloyd 1908) DW varied significantly across the two major landing sites (Bonfi and Boulbinet), in R (R Core team). To quantify the difference in landed species composition across Bonfi and Boulbinet, we employed Python 3.13.5 within a Jupyter Notebook environment. Key libraries employed included pandas, matplotlib, and scikit-learn for multivariate methods such as multidimensional scaling (MDS). To assess differences in species composition across Bonfi and Boulbinet, we calculated the Bray–Curtis dissimilarity index for (1) aggregated species composition for each site, and (2) for species compositions on each survey day for each site. The Bray–Curtis dissimilarity index provides a measure of dissimilarity robust to ecological count data and shared species absences. The index ranges from 0 to 1, where 0 indicates identical species composition and 1 represents completely different species compositions across sites. Higher values indicate greater dissimilarity between species at each site. The index is calculated by computing the sum of the absolute differences in counts of each species between the two samples, divided by the sum of the total count in both samples. We then tested statistical significance in a PERMANOVA test on the full, unaggregated daily sample-level Bray–Curtis distance matrix. This permutation-based multivariate analysis partitions variations within and between groups to test the hypothesis that community composition differs significantly by market. The test provides a pseudo-F statistic and associated p-value reflecting the extent and significance of compositional separation.

Furthermore, we conducted an Indicator Species Analysis to assess whether species were preferentially associated with one or the other market. Indicator values for each species-market combination were calculated following Dufrêne and Legendre (1997), based on species' relative abundance and frequency of occurrence within each group (market). Statistical significance was assessed through permutation tests involving 999 random shuffles of group labels, with p-values derived from comparison to a null distribution. The top ten indicator species per group were visualised with horizontal bar charts, displaying both indicator values and their significance.

Results

Fishery insight

Elasmobranch landings were recorded from both industrial fisheries as well as small-scale fisheries during the sampling period. Out of the 21 mobulids landed at Boulbinet, 18 were caught as bycatch from larger offshore (> 200 km) industrial vessels of Korean or Chinese origin using bottom trawls. The other 3 mobulids were landed by small-scale boats using drift gillnets and longlines. All mobulids landed during this study at Bonfi were from Ghanaian artisanal fishermen and caught inshore (< 200 km).

All of the other elasmobranch landing data at both Bonfi and Boulbinet were from landings during June and July by small-scale inshore boats. Documented gear types used for elasmobranchs landed at Bonfi were drift gillnets, set gillnets, hook and lines, and longlines. All gillnet types, and hook and line fishing were documented to be used near shore (< 120 km), whereas longlines were used inshore as well as offshore by artisanal vessels.

Species diversity

A total of 1,954 elasmobranch specimens were recorded, comprising 17 different species from seven families of sharks and nine families of rays. Guitarfishes (family Rhinobatidae) and giant guitarfishes (family Glaucostegidae) were the most commonly recorded groups throughout the study, accounting for 38.5% of the total catch in numbers. At Bonfi, 512 elasmobranch specimens were recorded, comprising 15 different species (Fig. 3a). Boulbinet surveys identified 1,418 individuals, comprising 17 species (Fig. 3b). During the six sampling days in Kassa, only two elasmobranch species were recorded: blackchin guitarfish (*Glaucostegus cemiculus;* Geoffroy St. Hilaire 1817) ($n = 7$) and common guitarfish (*Rhinobatos rhinobatos;* Linnaeus 1758) ($n = 17$).

Overall, Bonfi and Boulbinet had similar species compositions, which is reflected through a moderate dissimilarity index value and no significant differences in species composition across sites (Bray–Curtis dissimilarity index = 0.48; p-value = 0.12). However, when considering daily data, there were significant differences in species composition across sites ($p > 0.01$).

The four most common species recorded at Bonfi were common smooth-hound shark (*Mustelus mustelus;* Linnaeus 1758) ($n = 174$), milk shark (*Rhizoprionodon acutus:* Rüppell 1837) ($n = 145$), *G. cemiculus* ($n = 37$), and brown stingray (*Bathytoshia lata:* Garman 1880) ($n = 32$). Boulbinet's most recorded species were *G. cemiculus* ($n = 435$) and *R. rhinobatos* ($n = 255$). Similarly to Bonfi, the third and fourth most common species landed at Boulbinet were *R. acutus* ($n = 252$) and *M. mustelus* ($n = 213$).

Indicator Species Analysis indicated that silky sharks (*Carcharhinus falciformis;* Bibron 1845), bull sharks (*Carcharhinus leucas;* Valenciennes 1839), and *M. mustelus* were top-indicator species for Bonfi (with high specificity and fidelity), while the Atlantic weasel shark (*Paragaleus pectoralis;* Garman 1906) and Séret's butterfly ray (*Gymnura sereti;* Bloch and Schneider 1801) were key indicator species for Boulbinet (Fig. 4). *Glaucostegus cemiculus* was considered an indicator species for Boulbinet despite relatively lower site-specificity, with 37 individuals also recorded in Bonfi, due to a higher landing-site fidelity (more regular landings) in Boulbinet (Fig. 4).

Species status

Out of the 17 elasmobranch species recorded in this assessment, 15 are listed as threatened (Vulnerable, Endangered, or Critically Endangered) by the IUCN Red List (Table 1). Only two species recorded are currently listed as not threatened (Least Concern or Near Threatened). Eight species are listed in Appendix II of CITES to help protect their exploitation by restricting international trade in these species or their parts.

Mobulid ray catch

A total of 27 *M. thurstoni* were landed during the sampling period at Bonfi and Boulbinet. Disc widths ranged from 70 to 183 cm. Larger mature individuals ($n = 21$) between 160 and 183 cm were far more prevalent (especially in Boulbinet), with only a few smaller individuals ($n = 6$) between 70 and 94 cm (Fig. 5). Furthermore, the larger specimens were primarily composed of large mature males ($n = 20$ males and $n = 1$ female). Despite relatively small sample sizes, we found significant differences in disc width across sites (Gaussian GLM, $p < 0.001$), with generally larger specimens in Boulbinet (DW = 168 ± 20.3 cm) relative to Bonfi (DW = 107.7 ± 42.4 cm). While *M. thurstoni* are usually caught in drift or set gillnets, one specimen was documented on a longline (DW = 160 cm) (Table 2).

Species selling price

Selling price was recorded for 17 specimens, ranging from 10 different species, landed during October and December (2014) at Bonfi (Table 2). *Bathytoshia lata* was the highest-selling species (300,000 GNF, $42.70 USD), and the daisy whipray (*Fontitrygon margarita;* Günther 1870) was the lowest-selling individual and also had the smallest length (2,500 GNF, $0.35 USD). Guitarfish and shark species had lower selling prices than the stingray species of similar size. The largest measured individual was the scalloped hammerhead

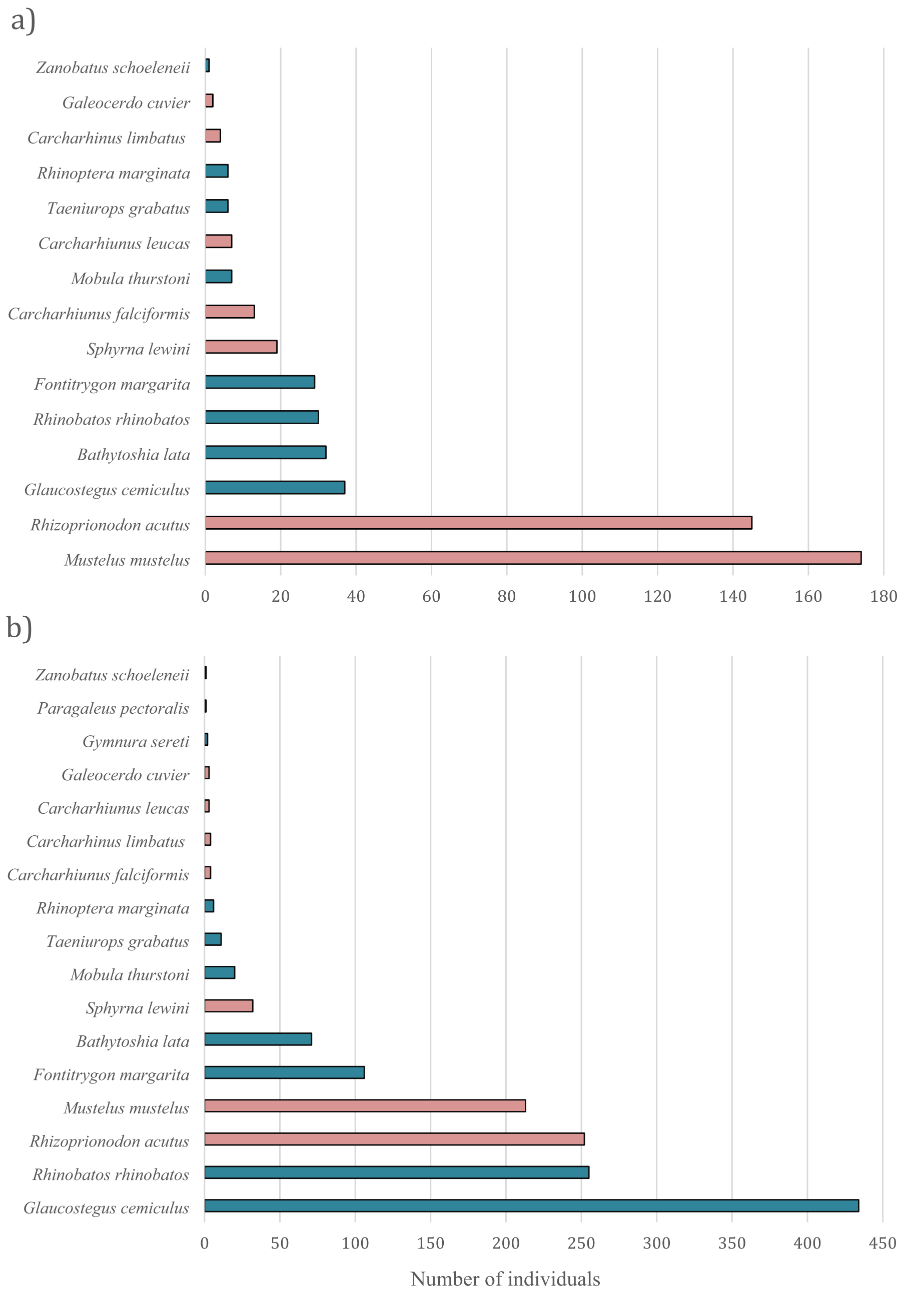

Fig. 3 Elasmobranch species landing total at **a** Bonfi and **b** Boulbinet. Red bars represent shark spp. and blue bars represent ray spp.

shark (*Sphyrna lewini;* Griffith and Smith 1834), which did not have the highest selling price (140,000 GNF, $19.93 USD).

Monthly catch

The highest projected monthly landing for both Bonfi and Boulbinet was in the month of March (Fig. 6). Boulbinet had the highest projected monthly landings with up to 1,655 individual elasmobranchs, relative to a maximum of 685 individuals at Bonfi. The total projected landings for both markets during the study period (10 months) were 6,134 elasmobranchs.

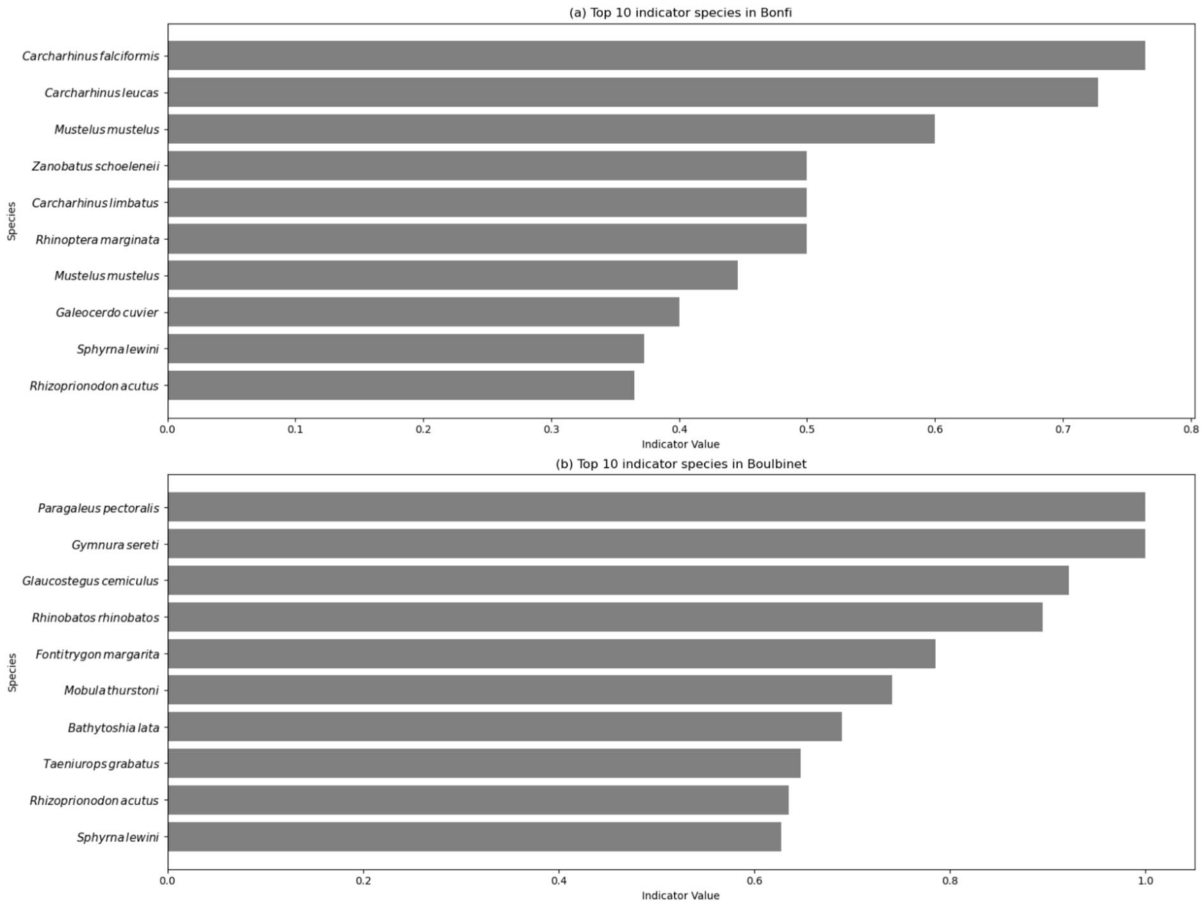

Fig. 4 Top 10 indicator species for Bonfi and Boulbinet, with significant Indicator Species values ($p < 0.01$).

Discussion

Threatened species dominate the catch

All of the elasmobranch species recorded during this study have listings on the IUCN Red List higher than Least Concern, 94% of which are assessed as threatened (vulnerable, endangered, or critically endangered). This study highlighted multiple trends in elasmobranch landings. First, a marked seasonality in elasmobranch landings was evident, with higher catches from February to April peaking in March. This peak occurs during Guinea's dry season, providing increased fishing opportunities during boreal winter upwelling conditions linked to the Guinea Current Large Marine Ecosystem (GCLME) off Guinea from December to March (Ukwe and Ibe 2010). Further research should aim to determine the seasonality of other target teleost species in these fisheries to inform spatio-temporal management measures. Second, despite similarities in elasmobranch species composition across major landing sites, such as high landings of guitarfishes and milk shark, species with higher fidelity and specificity to a given location indicate potential important shark and ray areas (i.e., for mating, feeding, or cleaning), which should be investigated further at the fine scale (Hyde et al. 2022).

Species of most concern (Endangered and Critically Endangered) with a high recorded catch were *G. cemiculus*, *R. rhinobatos*, *M. mustelus*, *S. lewini*, and *M. thurstoni.* Among these species, *G. cemiculus, R. rhinobatos*, and *M. mustelus* are exclusively restricted to coastal, shallow, or shelf waters, exposing them to intense fishing pressure from artisanal fisheries operating nearshore (Stewart et al. 2010; Haque et al. 2021). While *S. lewini* is not restricted

Table 1 IUCN Red List status and CITES Appendix listing of the species recorded at Guinean fish markets, with the date of the last assessment and the total number observed during the course of this study (www.iucnredlist.org)

Species	Common name	Total number recorded	IUCN status	Year last assessed	CITES listing
Glaucostegus cemiculus	Blackchin Guitarfish	478	Critically endangered	2018	Appendix II
Rhizoprionodon acutus	Milk Shark	397	Vulnerable	2020	Appendix II
Mustelus mustelus	Common Smoothhound Shark	387	Endangered	2020	
Rhinobatos rhinobatos	Common Guitarfish	302	Critically endangered	2020	Appendix II
Fontitrygon margarita	Daisy Whipray	135	Vulnerable	2020	
Bathytoshia lata	Brown Stingray	103	Vulnerable	2020	
Sphyrna lewini	Scalloped Hammerhead Shark	51	Critically endangered	2018	Appendix II
Mobula thurstoni	Bentfin Devil Ray	27	Endangered	2018	Appendix II
Carcharhinus falciformis	Silky Shark	17	Vulnerable	2017	Appendix II
Taeniurops grabatus	Round Stingray	17	Near threatened	2020	
Rhinoptera marginata	Lusitanian Cownose Ray	12	Critically endangered	2020	
Carcharhinus leucas	Bull Shark	10	Vulnerable	2020	Appendix II
Carcharhinus limbatus	Blacktip Shark	8	Vulnerable	2020	Appendix II
Galeocerdo cuvier	Tiger Shark	5	Near threatened	2018	
Gymnura sereti	Séret's Butterfly Ray	2	Endangered	2020	
Zanobatus schoenleinii	Striped Panray	2	Vulnerable	2020	
Paragaleus pectoralis	Atlantic Weasel Shark	1	Endangered	2020	

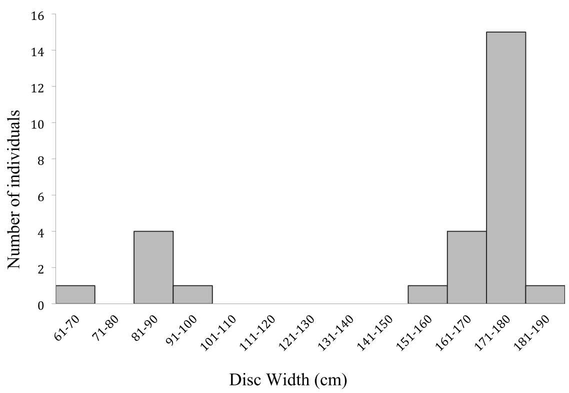

Fig. 5 Disc width measurements of *Mobula thurstoni* (bentfin devil ray) landed at Bonfi and Boulbinet (n = 27) throughout the entirety of the study (October 2014–June 2015)

to shallow waters, with more advanced life stages venturing into pelagic habitats, neonates and juveniles inhabit shallow nursery areas that expose them to capture in coastal artisanal fisheries in the region (Castro 1993; Diemer et al. 2011; Simpfendorfer and Milward 1993). Such fishing pressure can lead to localised species extinction, as already documented in the sawfishes (*Pristis* spp.) off West Africa, or to severe declines, as reported in guitarfishes, *Gymnura* spp., requiem sharks, and hammerhead sharks throughout the region (Diop and Dossa 2011; Leeney and Poncelet 2015; Dulvy et al. 2016; Yan et al. 2021; Leurs et al. 2025). There has also been some indication of local extinctions of *S. lewini* in parts of West Africa, suggesting an uncertain future for this species in Guinea (Anon. 1997).

Mobula thurstoni, on the other hand, possesses a more pelagic lifestyle (Stewart et al. 2018). The prevalence of neonates and small juvenile *M. thurstoni* at Bonfi, and the absence of intermediate size-classes, suggests that fishing grounds overlap with important areas for early life stages of this species, and constitute a potential pupping and nursery ground. Based on the smallest *M. thurstoni* (DW = 70 cm) landed in this study, which was documented to be free swimming (established on anecdotal information obtained from fishers), the size at birth is likely to be at or around this size in the West African region. There is limited information available on birth size for *M. thurstoni,* but Notarbartolo-Di-Sciara (1988) reported disc widths of embryos from 21 to 63 cm, with an estimated birth size between 65 and 85 cm. Notably, no other mobulid ray species were recorded during

Table 2 Selling price of specimens landed at Bonfi in October and December 2014

Species	Length (cm)	Selling price (GNF)	Price in USD	Gear Type
Fontitrygon margarita	26	$2500	$0.35	Undetermined
Glaucostegus cemiculus	69	$15,000	$2.14	Drift gillnet
Rhizoprionodon acutus	81	$4500	$0.64	Longline
Mustelus mustelus	85	$5000	$0.71	Fishing nets and lines
Glaucostegus cemiculus	103	$40,000	$5.69	Drift gillnet
Carcharhinus leucas	117	$25,000	$3.56	Drift gillnet
Glaucostegus cemiculus	124	$140,000	$19.93	Drift gillnet
Bathytoshia lata	124	$220,000	$31.32	Set gillnet
Galeocerdo cuvier	126	$38,000	$5.41	Drift gillnet
Bathytosia lata	126	$300,000	$42.70	Set gillnet
Carcharhinus falciformis	129	$130,000	$18.51	Longline
Galeocerdo cuvier	144	$45,000	$6.41	Drift gillnet
Mobula thurstoni	160	$160,000	$22.77	Longline
Sphyrna lewini	160	$120,000	$17.08	Fishing nets and lines
Glaucostegus cemiculus	180	$140,000	$19.93	Drift gillnet (180 mm)
Glaucostegus cemiculus	194	$120,000	$17.08	Drift gillnet
Sphyrna lewini	198	$140,000	$19.93	Fishing nets and lines

M. thurstoni, B. lata, and *F. margarita* were measured from tip of pectoral fin to the other giving the disc width. All other species were measured from the tip of the rostrum to the end of the tail giving the total body length. Gear used to catch each species was recorded at the time of landing

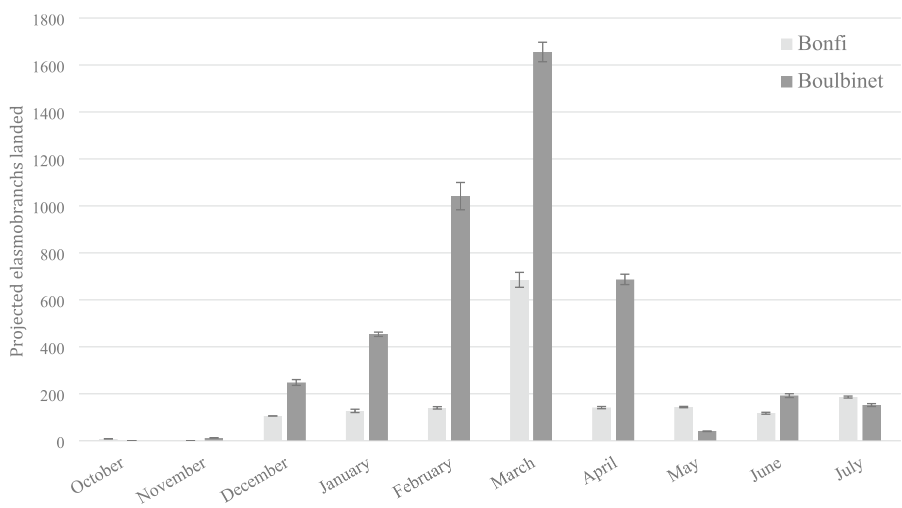

Fig. 6 Projected number of elasmobranchs landed during the sampling period

our study. However, four other species were recorded in West and Central African fisheries: Atlantic pygmy devil ray (*Mobula hypostoma*; Bancroft 183), oceanic manta ray (*Mobula birostris*; Walbaum 1792), sicklefin devil ray (*Mobula tarapacana*; Philippi 1892), and spinetail devil ray (*Mobula mobular;* Bonnateree 1788) (Seidu et al. 2021; Doherty et al. 2023; Labyedh et al. in press). Larger oceanic mobulid species, such as *M. birostris* and *M. tarapacana*, tend to occur further offshore; therefore, they may also occur in Guinea's EEZ despite no records in the current study (Stewart et al. 2018; Seidu et al. 2021).

Guitarfish species dominated the overall catch at all sampled fish markets. Globally, these species have declined in population size to low levels, with most now assessed as Critically Endangered, including the two species seen during this study, *G. cemiculus and R. rhinobatos* (Moore 2017; Jabado 2018; Kyne et al. 2020). The use of gillnets within 120 km of the shore may have contributed to the high landings of these species since they are known to inhabit shallow soft-bottom areas (Moore 2017). Among other top-landed batoids in this study was *F. margarita*, which is listed as Vulnerable by the IUCN and is endemic to the West and Central Africa Regions. This means local populations have limited potential for recovery relative to species with more circumglobal distributions (Dulvy et al. 2014). This species is prevalent in coastal fisheries in the regions due to its shallow, brackish water habitat that overlaps with fishing grounds (Carpenter and De Angelis 2016; Krakstad et al. 2007; Last et al. 2016). Another closely related species, usually landed in combination with *F. margarita*, pearl whipray (*Fontitrygon margaritella;* Compagno and Roberts, 1984) (Last et al. 2016), was not recorded during this study. This could have been due to the limited survey duration, difficulty in distinguishing it from the closely related species *F. margarita*, or habitats that did not overlap with the fisheries recorded here.

Trends in landings composition

This study identified 17 elasmobranch species, which represent less than half of the known species that inhabit Guinean waters (Diop and Dossa 2011). Previous work determined that Blacktip shark (*Carcharhinus limbatus*; Valenciennes in Müller and Henle 1839), *G. cemiculus,* and *C. leucas* were important mainstays of Guinean fisheries (Diop and Dossa 2011), while the current study shows that *M. mustelus*, *R. acutus*, *G. cemiculus*, and *R. rhinobatos* were dominant. While our study was limited temporally, changes in landings could be due to several factors. If this change in dominant species reflects a shift in abundance, it supports the conclusion that fishing has affected the elasmobranch community in Guinean waters. Conservative life history traits (e.g., slow growth, late maturation, and low fecundity) make elasmobranchs particularly vulnerable to overfishing and susceptible to population declines (Compagno 1990; Frisk et al. 2001). In general, smaller elasmobranch species, typically inhabiting inshore areas, have faster growth rates and higher reproductive rates compared to large species, enabling them to sustain higher fishing pressure and recover more quickly when depleted (Smith et al. 1998; Garcia et al. 2008; Rigby and Simpfendorfer 2015). Regions with sustained fishing effort often see a change in species composition linked to life-history characteristics, with the smaller, more productive species becoming more commercially important over time as less productive species decline (Lam and Sadovy de Mitcheson 2011; Seidu et al. 2021). These smaller species, in turn, are more likely to become threatened with an elevated risk of extinction if fishing pressure continues (Dulvy et al. 2014).

Both *M. mustelus a*nd *R. acutus* are relatively small, productive species (Garcia et al. 2008; Rigby and Simpfendorfer 2015) that may have become more dominant than the larger, less productive species, such as *C. limbatus* and *C. leucas*. The guitarfishes, *G. cemiculus* and *R. rhinobatos*, accounted for almost 40% of the elasmobranch landings at Bonfi and Boulbinet in this study, and are still important to subsistence fishers, as previously documented (Diop and Dossa 2011). *Rhizoprionodon acutus* was also previously thought to be the only species whose relative abundance was increasing in the region (Diop and Dossa 2011), further supporting the hypothesis that there have been changes in the elasmobranch community. Species comparisons cannot be made for the other species recorded here because there is no previous documentation of relative abundance. However, to make a definitive conclusion concerning changes in species composition and population declines, longer-term fisheries monitoring is needed, and obtaining catch per unit effort (CPUE) information for these landings will be crucial.

Nevertheless, governmental data obtained in the scope of a National Plan of Action raises concern for shark and ray stocks in Guinean waters. Official data show important declines in the volume of sharks landed from 1999 to 2010 (Diop and Dossa 2011; Doumbouya and Traore 2014). These decreasing trends, despite growing fishing effort, have been attributed to a collapse in elasmobranch stocks due to overfishing (Doumbouya and Traore 2014), which is reflected in the complex socio-economic dynamics of the fisheries. The demand for shark fins and meat led fishers from other West African countries, such as Ghana, Senegal, and Mali, to exploit local stocks, with only limited Guinean fishers participating in this fishery (Doumbouya and Traore 2014). The resulting increase in fishing pressure led to a stock collapse, and many foreign fishers abandoned their activity off Guinea or transitioned to other fishing sectors (Doumbouya and Traore 2014).

A significant limitation in this study was the lack of elasmobranch landing data from industrial fisheries, with only mobulids recorded opportunistically. A general lack of openly accessible data from industrial fleets in the West and Central Africa region currently hinders the production of reliable national catch estimates for elasmobranch species, and the extrapolated landings we provide here are likely underestimated. Soumah et al. (2021) report that 90 industrial fishing vessels operated in Guinea waters in 2020 (of which 7 were under the Guinean flag), comprising 39 tuna seiners, as well as demersal trawlers, pelagic fish trawlers, and shrimp boats. Furthermore, illegal fishing by industrial vessels is rampant in Guinea, where 65–95% of industrial landings in 2016 were by unlicensed vessels (Meredith 2017). Diop and Dossa (2011) suggested that the industrial fisheries from Guinea rank among the highest bycatch of elasmobranchs in West Africa. Yet, shark data is lacking from national statistics, despite the Centre National des Sciences De Halieutiques De Boussara (CNSHB) recording 1,765 metric tonnes (mt) of rays landed in Guinea in 2018, 3,571 mt in 2021, and 2,738 mt in 2022, with ~ 96% of the catch by artisanal fisheries (CNSHB, 2020, 2021, 2022). Diop et al. (in Jabado et al. 2024) report that many of the 47 elasmobranch species documented in Guinea are now locally extinct or no longer caught despite sustained fishing effort at similar locations where they were previously sighted, raising serious concern for local population sustainability. While catch numbers from this study are still challenging to contextualise, the estimated projection of ~ 6,134 elasmobranchs landed at fish markets in this study over 10 months appears to be below recent national catch statistics for rays, and those reported to the FAO in 2014–2015, which is expected given the geographical limitation of this study. Namely, FAO marine production statistics show that Guinea reported catching 403 mt of 'sharks, rays, skates, etc. NEI' (NEI: not elsewhere included) in 2014, and 200 mt in 2015 (FAO, FishStat 2025). In comparison, Ghana reported 5,824 mt of elasmobranchs in this category in 2014 and 8,071 mt in 2015, while Sierra Leone landed an estimated 3,300–3,400 mt of elasmobranchs in 2014–2015 (FAO, FishStat 2025). While clear under-reporting is rampant, including Guinea fisheries, catch statistics reported to FAO have increased in recent years, despite continued low reporting by countries like Senegal (FAO, FishStat 2025).

Market value of sharks and rays

The primary drivers of worldwide elasmobranch fisheries are the high value obtained for the sale of the fins and meat harvested from larger sharks and rays for international trade (Vannuccini 1999; Diop and Dossa 2011; Dulvy et al. 2014). The local fishery dependence in Guinea may not be based on the larger species landed; instead, it is more reliant on the profits generated from the smaller, more abundant species for the meat trade. Yet, the large shark species in this study, *Carcharhinus* spp., tiger shark (*Galeocerdo cuvier*; Péron and Lesueur 1822), and *S. lewini,* were profitable in Guinea, with sale prices varying depending on species, size, and specimen quality. However, rays of smaller size were sold for high prices, suggesting that the main driver at Bonfi and Boulbinet is the meat of the elasmobranch, rather than large fins, which have been documented in other fishing communities (Pissarra et al. 2024; Seidu et al. 2022).

Although meat may be the dominant driver of the price paid for elasmobranchs in markets, Guinea is a confirmed source country in the international trade in shark fins, and the volume of shark fin exports has decreased from 1999 to 2010, in parallel with decreases in shark landings over the same period (Doumbouya and Traore 2014). The top landed species recorded here are also highly sought after for their fins in the trade. For instance, guitarfish fins are in demand due to the high market value for their 'white' fins (Moore 2017), which are increasingly sought after throughout their range (Kyne et al. 2020). Similarly, demand for the fins of *S. lewini* and many *Carcharhinus* spp. internationally led to their listing on CITES Appendix II in an effort to regulate trade. While mobulid rays are also sought after internationally for their gill plates, no evidence of gill plate extraction for exportation was found in this study.

Management implications and future directions

In Guinea, the known elasmobranch conservation measures in place include increased shark fishing licence costs (from $1,000,000 GNF to $5,000,000 GNF, $97.34 USD to $486.68 USD), a ban on targeted shark finning in all territorial waters since 2009, and a ban on targeted shark fishing and incidental capture for seven elasmobranch species since 2010 (Diop and Dossa 2011). Additionally, Guinea is a party to several multilateral treaties and agreements, including CITES, CMS, and the International Commission for the Conservation of Atlantic Tunas (ICCAT). Shark and ray provisions adopted by ICCAT include a ban on shark finning, a retention ban on bigeye thresher sharks (*Alopias superciliosus;* Lowe 1841), oceanic whitetip sharks (*Carcharhinus longimanus*; Poey 1861), most hammerhead species (incl. *S. lewini*, with exceptions), silky sharks (with exceptions), and measures for certain pelagic sharks (i.e., shortfin mako (*Isurus oxyrinchus;* Rafinesque 1810) and blue shark (*Prionace glauca;* Linnaeus 1758)). Coastal fisheries capturing hammerhead and silky sharks for local consumption in developing nations that are contracting parties to ICCAT are exempt from the retention ban, as long as landings are reported, catches are capped, and international trade is prevented (ICCAT Rec. 10–08, ICCAT Rec. 11–08). This study shows that Guinea is currently in breach of CMS provisions to impede landings of mobulid rays. Enforcement of the above domestic protection measures and international agreements is low, with shark catches generally going unreported. For example, the Ministry of Fisheries and Maritime Economy and other national authorities ceased collecting data on shark landings after the ban on their capture (Jabado et al. 2024). Given this context, the current study represents a unique insight into shark and ray captures in Guinea, despite its spatial and temporal limitations. However, this also highlights an urgent need for local authorities to monitor and disclose all elasmobranch landings, including those of sharks, which still occur despite unenforced domestic protections. Addressing this issue will require holistic measures aimed at managing fisheries within complex socio-economic systems in artisanal fishing, improving spatial management to incorporate important habitats for sharks and rays, as well as monitoring elasmobranch take by industrial vessels to enforce domestic protections (Booth et al. 2019; Leurs et al. 2025).

West Africa is known to have a large number of foreign vessels exploiting the local resources (Kaczynski and Fluharty 2002; Pauly et al. 2014). During this study, Chinese (and possibly Korean) vessels were documented landing *M. thurstoni* catch at Boulbinet. The overall impact of these foreign vessels is unknown; however, the documentation of catch landed by foreign vessels in this study suggests they have some level of impact. Elasmobranch landings by Ghanaian and Senegalese fishermen have previously been documented in West Africa (Diop and Dossa 2011), indicating high utilisation of Guinea waters by neighbouring nations. This suggests high exploitation in Ghana, which is potentially impacting Guinea's local populations (Seidu et al. 2021). Given the economic benefit of elasmobranchs for Guinea and the likely population declines resulting from unregulated fishing pressures, there is an urgent need for additional conservation efforts for these species locally. Furthermore, to ensure informed conservation management decisions are made, focused research to determine the regional (and global) status of all elasmobranch species is essential, especially those that are listed in the highest threat categories.

While Guinea has made progress towards spatial management of marine resources by declaring Marine Protected Areas (MPAs) in some coastal regions, enforcement is generally lacking. This, however, provides a basis for improving the protection of important shark and ray habitats, especially in areas with a high abundance of highly threatened species and potential nursery or foraging grounds (Kyne et al. 2023). Further research should aim to obtain fine-scale catch-location data, for example, by deploying onboard GPS units in artisanal fisheries to support spatial planning. Moreover, industrial fisheries data should be better documented.

Conclusions

This study provides species-specific estimates of elasmobranch catch composition in Guinea. There is evidence of high fishing pressure on threatened elasmobranch species, such as the guitarfish species, that could result in rapid population collapses. However, further research will be necessary to truly assess the effect of fishing on each species. Food security is a major driver of the fishery, which may inhibit the level of conservation or restrictive management implemented within the region. Gaining local support of conservation management from within the fishing community is integral to effective conservation in Guinea. If this can be achieved, proactive management measures would ultimately guarantee both food security and the conservation of threatened species. The prevalence of both small-scale fishers and fleets utilising Guinean waters will make management efforts more challenging without changes in high-level policy measures and visions. Further studies are needed in order to understand the status of key species and to develop appropriate management actions.

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Data availability Data available upon request.

Declarations

Ethics approval and consent to participate Dr. Guy Stevens is a Guest Editor on this special issue but was not involved in the peer review of this article and had no access to information regarding its peer review.

Conflicts of interest The authors declare that they have no conflicts of interest.

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