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Composition and biology of elasmobranchs in the shore seine catches of Malvan, Maharashtra

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Original Article

Abstract

Shore seines are traditional fishing gear that supports the livelihoods and subsistence of thousands of fishers in India. However, their impact on elasmobranchs that inhabit the coastal waters is relatively less known. This study assessed elasmobranch capture, biology, and their value from inshore seines of Malvan, Maharashtra. Six elasmobranch species were found in the shore seine nets, dominated by the scaly whip ray (*Brevitrygon walga,* n=107) and including two Critically Endangered guitarfish species (*Glaucostegus obtusus* and *G. granulatus*). Most captured elasmobranchs were juveniles, suggesting that the inshore Malvan waters may serve as nursery grounds for these species. Among the sampled *B. walga* 64.1% were dead upon capture, with small-sized rays showing significantly higher mortality, indicating a higher vulnerability of juveniles. 49.5% of the captured elasmobranchs were discarded, 19.6% were used as take-home catch for consumption and only 30.9% were commercially sold, albeit for a low value. These findings indicate that while the shore seine fishery may affect coastal elasmobranchs, these species are important for local subsistence. Conservation efforts can be directed towards the live release of elasmobranchs that would otherwise be discarded and die, particularly for endangered species.

Keywords: *Shark, ray, chondrichthyes, fisheries, bycatch*

Introduction

The shore seine is a traditional fishing practice carried out across the globe and is commonly operated by fishing communities along India's coastline (Pravin, 2014). Shore seines operate close to the shore, where a large net is manually towed by groups of fishers on the shore in a semi-circular manner (Tietze *et al.*, 2011). Also known as beach seines and drag nets, this fishery supports the livelihoods and food security of small-scale fishing communities across the country and is known for its participatory and sustainable mode of operation (Nirmale and Metar, 2003; Tietze *et al.*, 2011). However, shore seines are not without impacts on marine ecosystems. Multiple studies have recorded high catches of juveniles in these nets, due to the small mesh sizes and non-selective nature of this gear (Saleela *et al.*, 2015; Raj *et al.*, 2017; Surya *et al.*, 2018). Furthermore, shore seines often operate in shallow productive waters that form important feeding, breeding and nursery grounds for numerous marine fauna, including vulnerable and threatened species (Kharatmol *et al.*, 2006). Elasmobranchs (sharks and rays) are one of the most threatened marine species groups globally. This is due to their slow growth, late maturity, low fecundity and other life-history characteristics (Dulvy *et al.*, 2014). Coastal environments generally support high biodiversity and productivity, therefore often forming important habitats for many elasmobranch species (Yates *et al.*, 2012). Elasmobranchs also use shallow bays and inshore waters as pupping and nursery grounds (Springer, 1967). These coastal populations are particularly vulnerable to capture and mortality in fisheries operating here (Speed *et al.*, 2010), including shore seines (Velasco *et al.*, 2011).

The *Rampani* is an indigenous shore seine fishery operating along the Konkan and Malabar coasts, on the west coast of India (Pravin, 2014). The *Rampani* in Sindhudurg, Maharashtra, operates through a rotation system for more effective and sustainable resource management (Nirmale and Metar, 2003). Sindhudurg is known for its productive, shallow coastline interspersed with corals, mangroves and estuaries, and hosts the Malvan Marine Sanctuary, one of India's marine protected areas (UNDP, 2013). However, this region faces immense pressure from fisheries and other activities (Kharatmol *et al.*, 2006).

Elasmobranchs are frequently captured by trawlers and gillnets in Malvan (Gupta *et al.*, 2020); however, little is known about their interaction with shore seine fisheries. Understanding elasmobranch capture and inshore seines can help improve the management of these fisheries. This study aimed to assess the composition, biology and value of elasmobranchs captured by shore seine fisheries in Malvan.

Material and methods

This study was carried out in Malvan, in the Sindhudurg District of Maharashtra. At least six different shore seine units (locally known as *Sanghs*) are operating in and around Malvan's Dandi beach, each comprising 20-30 fishers. Shore seine nets were usually cast between 01:00-02:00 am and hauled in about 4 hours later, on average. The nets were 500-1000 m in length and with 10 mm mesh size and were cast at an average depth of 9 m. The main target species were mackerel (*Rastrelliger kanagurta*), ribbonfish (Trichiuridae), sardines (Clupeidae) and anchovies (Engraulidae).

Sampling was conducted between November 2019 to March 2020. The shore seine fishery was sampled 3 times a week on alternate days, between 06:00-07:30 am when the nets were hauled in and the catch was sorted. On each day, a single shore seine unit was sampled at random, depending on which unit was operating. Captured elasmobranch species were identified and the total abundance of each species was recorded. Wherever possible, the elasmobranchs were measured (total length TL for sharks and guitarfish, disc width DW for rays), weighed and sexed, and male maturity (as immature, maturing or mature based on clasper calcification; Tyabji *et al.*, 2020) was recorded, and the mortality status (alive or dead) was noted. The fate of each elasmobranch (discarded, commercially sold or take-home catch) was recorded whenever possible. Data were analysed on R Studio (Version 1.2.5033; R Studio, 2020) to produce descriptive statistics of the elasmobranch catch and assess relationships between mortality and size.

Results and discussion

Species composition and biology

A total of 39 shore seine hauls were sampled over the study duration. 18 of these hauls had captured elasmobranchs, with 132 individuals in total. 6 elasmobranch species were encountered, dominated by the scaly whip ray (*Brevitrygon walga*, Müller and Henle, 1841, n=107). It should be noted that *B. walga* has been historically confused with the Bengal whip ray (*B. imbricata*, Bloch and Schneider, 1801), and there remains considerable taxonomic confusion on *B. walga* with different forms across its range (Last *et al.*, 2016). Hence *B. walga* may represent a species complex and further research is needed on its taxonomy. Similarly, the Pakistan whip ray (*Maculabatis arabica,* Manjaji-Matsumoto and Last, 2016) and the shorttail whip ray (*M. bineeshi,* Manjaji-Matsumoto and Last, 2016) are morphologically similar species and could not be accurately distinguished in the present study. These individuals were collectively recorded as *Maculabatis* sp. and were the second most abundant elasmobranch in the shore seine. Two Critically Endangered species of guitarfish (*G. obtusus*, Müller and Henle, 1841 and *G. granulatus,* Cuvier, 1829), as well as the white-spotted whip ray (*M. gerrardi*, Gray, 1851) and the grey bamboo shark (*Chiloscyllium griseum*, Müller & Henle, 1838), occurred in small numbers. Details on the abundance, size and sex ratio of the sampled species are given in Table 1.

The majority of the sampled males of *B. walga* (73.1%) were immature juveniles (based on clasper length and calcification), with only a single mature male encountered. Although female maturity could not be classified in the present study, sizes at maturity of *B. walga* and related species obtained from the literature indicate that females mature between 18-22 cm DW (Last *et al.,* 2016), suggesting that at least 87% of the sampled females could be immature. A gravid female of *B. walga*

Table 1. Summary of the total abundance, size, and sex ratio of the sampled elasmobranchs.

Common name	Scientific name	IUCN status[1]	Total abundance	Size[2] (cm)	Sex ratio (% and no. of females)
Scaly whipray	*Brevitrygon walga*	NT	107	13.2 ± 3.2 Min: 8.3 Max: 24.2	36.1% (n=30)
Pakistan whipray/ Shorttail whipray	*Maculabatis* sp.	NE	18	22.0 ± 2.4 Min: 17.5 Max: 25.5	76.9% (n=10)
Widenose guitarfish	*Glaucostegus obtusus*	CR	4	34.5 ± 15.5 Min: 21 Max: 48	75.0% (n=3)
Sharpnose guitarfish	*Glaucostegus granulatus*	CR	1	21.0	100.0% (n=1)
White-spotted whipray	*Maculabatis gerrardi*	VU	1	23.2	0 (all male)
Grey bamboo shark	*Chiloscyllium griseum*	NT	1	68.0	100.0% (n=1)

1Species status as per the International Union for Conservation of Nature's Red List (IUCN, 2020). NT: Near Threatened, NE: Not Evaluated, CR: Critically Endangered, VU: Vulnerable. 2Size refers to total length for sharks and guitarfish, and disc width for stingrays. For each species, mean size is given along with standard deviation (mean ± SD), as well as minimum and maximum size. 1Species status as per the International Union for Conservation of Nature's Red List (IUCN, 2020). NT: Near Threatened, NE: Not Evaluated, CR: Critically Endangered, VU: Vulnerable. 2Size refers to total length for sharks and guitarfish, and disc width for stingrays. For each species, mean size is given along with standard deviation (mean ± SD), as well as minimum and maximum size.

(22 cm DW, 460 g) with two pups was observed in January. For all other species, all sampled males were immature. The number of elasmobranchs captured greatly varied over the sampling duration. High abundance was seen in January 2020, with nearly every sampled haul capturing elasmobranch and abundances as high as 32 rays per haul (Fig. 1). Elasmobranch capture was low in other months, especially in February and March (Fig. 1), when fish catch in the shore seine was low overall. The present study was carried out over a relatively short duration, and greater elasmobranch diversity might be recorded over the entire fishing season. A more detailed study of this fishery is needed for a more robust dataset.

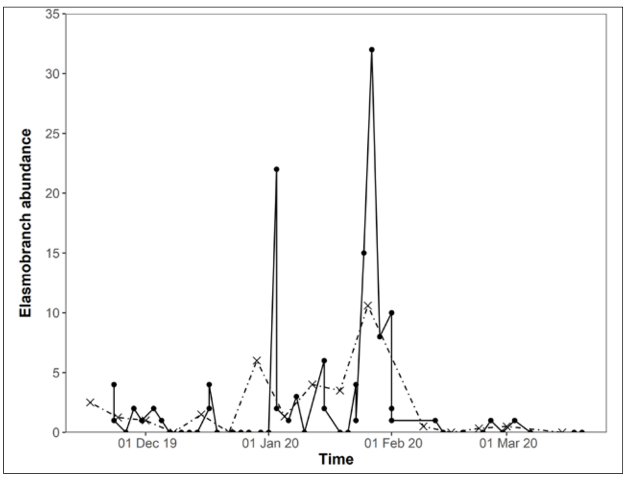

Fig. 1. The abundance of elasmobranchs (all species) per sampling day (solid line and dots) and per week on average (dashed line and crosses) in the shore seine net over the duration of the study

Mortality and survival

Most of the sampled individuals (64.1%, n=50) of *B. walga* were dead upon capture. For all other species, most of the sampled individuals were alive (76.9% for *Maculabatis* sp., 75% for *G. obtusus*, and 100% for all other species). The relationship between size (i.e. disc width) and survival upon capture (alive or dead) for *B. walga* was analysed by a Kruskal Wallis test, as the data were not normally distributed. Survival was found to vary significantly with size (KW H = 9.03, $p<0.01$), with dead individuals smaller than live ones (Fig. 2). In other words, juveniles of *B. walga* had a higher mortality rate upon capture. Mortality was most likely caused by asphyxiation due to removal from water, but may also be due to physical trauma from the mass of catch or injury from jellyfish (Broadhurst *et al.*, 2008; Frick *et al.,* 2010)

Utilisation

Around 49.5% of elasmobranchs caught in inshore seines were discarded on the beach (Fig. 3), 19.6% were kept by fishers as

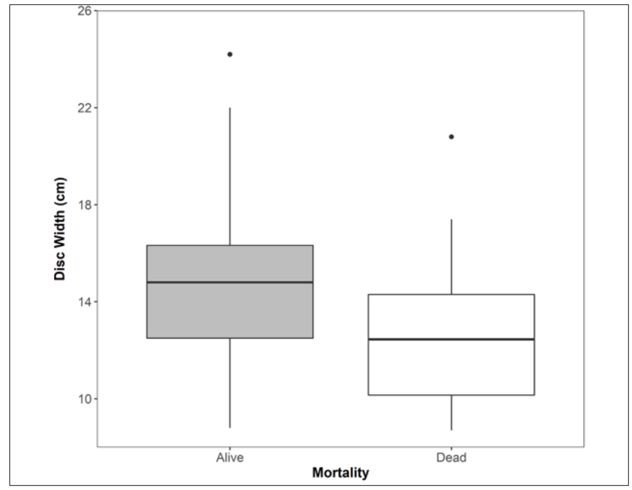

Fig. 2. Size range (in terms of disc width) of live and dead *B. walga* individuals after capture. Dead rays were found to be significantly smaller than live rays

take-home catch for personal consumption and only 30.9% were commercially sold, particularly larger-sized individuals. Of this, 8.2% was sold (along with a mass of other catch) for fishmeal production. In general, elasmobranchs were sold for a low value, particularly when sold for fishmeal. The high discard rate of elasmobranchs (Fig. 3) suggests that these species are largely considered bycatch in the shore seine net. However, the use of these species by traditional fishers for subsistence should be noted, as it provides further evidence for the importance of elasmobranchs as a cheap food source in the country (Jabado *et al*., 2018)

Implications

The high abundance of juvenile rays, particularly of *B. walga* and *Maculabatis* sp., suggests that these inshore waters of Malvan may serve as nurseries for these species. Rays (*i.e.* batoids) are known to use shallow, coastal waters as nurseries, with juveniles remaining in a restricted area for weeks to months

Fig. 3. Sting rays discarded on the beach after capture in a shore seine

(Martins *et al*., 2018). Limited data exists on the biology, breeding and behaviour of the ray species; catch from shore seines may serve as a medium to study these species and gain much-needed insights. The presence of Critically Endangered guitarfish species, although in low numbers, is concerning. Giant guitarfish (*Glaucostegus* sp.) have been severely declining across the globe due to high fishing pressure and limited biological productivity (Kyne *et al*., 2020). Further research on these species is critical, particularly regarding their movement and habitat use to minimise fisheries impacts.

Mesh size regulations can reduce the capture of juvenile elasmobranchs and other fish species (Tietze *et al*., 2011; Raj *et al*., 2017). However, increasing the mesh size of shore seine nets may lead to the loss of small pelagic fish that form valuable catch. Mesh size regulations are not always complied with in Indian fisheries (Kumar and Deepthi, 2006). Hence, a post-capture release may be a more effective measure for threatened bycatch species. Overall, mortality rates of elasmobranchs were relatively low in shore seines, particularly compared to mechanised fishing gear (Broadhurst *et al*., 2008). Live release programmes for elasmobranchs, especially endangered species like guitarfish, may be successful given their high discard rate and low economic value. This can be implemented through awareness programmes with fishers and training to release live bycatch species back into the water. However, as juvenile rays were found to be at a higher risk for mortality, releasing them after capture may not be effective and other measures also need to be considered.

Conclusion

Many coastal fisher communities in India depend on shore seine fisheries for their livelihood and subsistence. However, the catch of threatened elasmobranch species, especially juveniles, indicates that this fishery can be better managed to protect vulnerable marine fauna. Conservation efforts can be directed towards the live release of threatened species while safeguarding the needs of traditional fishers. The findings of this study also provide further evidence for the importance of Malvan's waters for marine biodiversity (UNDP, 2013) and emphasize the need for further research and improved management in this region.

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