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Sawfish exploitation and status in Bangladesh

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ABSTRACT

1. Sawfish are among the world's most threatened and understudied marine fishes. There are few studies on sawfish from outside Australian and USA waters - a significant knowledge gap considering their circumtropical distribution and migratory nature.

2. This paper presents the first assessment of sawfish exploitation and status in Bangladesh: a country that is subject to extensive fishing efforts, and home to the largest mangrove forest on Earth – an ecosystem that provides critical nursery habitat for juvenile sawfish.

3. A countrywide rapid assessment was undertaken between December 2011 and November 2012, using an interdisciplinary methodology. Fish landing stations, dry fish markets, and fishing villages were visited and a sawfish medicine maker was found and interviewed. In addition, interviews with national specialists at academic and fisheries institutions were undertaken. In total, 203 questionnaire surveys were conducted with fishers and traders in order to understand the extent of decline, potential drivers of declines, and local perceptions and uses of sawfish. Eighteen rostra were documented from museum archives and private collections, and unpublished data were sourced.

4. Two sawfish species, *Pristis pristis* and *Anoxypristis cuspidata* were confirmed to be present in Bangladesh. General population declines were revealed. The average annual sawfish encounter rate (observations and catches) declined from 3.7 individuals using lifetime recall data (~22-year), to 1.5 using 5-year recall data, and further to 0.7 using 1-year recall data.

5. The consensus from social research methods was that sawfish were caught as bycatch, with drift gill nets being cited as the most damaging gear type. Every respondent perceived sawfish as a useful animal – typically for medicinal or cultural values. Conservation measures are proposed, including a local education and outreach programme to seek behavioural changes – primarily to release live sawfish.

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INTRODUCTION

Background

Sawfish (family Pristidae) are a group of benthic elasmobranchs characterized by their toothed rostra. For centuries, sawfishes have been important as valuable food and medicinal resources and as religious and cultural symbols (Robillard and Séret, 2006; Clarke *et al*., 2007). They are now considered among the most threatened marine animals in the world (CITES, 2007; IUCN, 2013) with all five species categorized as 'Endangered' or 'Critically Endangered' on the IUCN Red List (IUCN, 2013) and listed on Appendix I of CITES, banning their international trade (CITES, 2013).

While present across a broad spectrum of salinities, sawfish prefer coastal marine and estuarine environments (Poulakis and Seitz, 2004; Peverell, 2005; Whitty *et al*., 2009; Norton *et al*., 2012). Pupping often occurs within mangrove forests – a critical habitat for juveniles because these forests provide abundant food, while prop roots facilitate predation avoidance (Simpfendorfer *et al*., 2010). Juveniles of *Pristis pectinata* prefer waters <0.9 m in depth, but as individuals mature (>180 cm total length) they tend to migrate from creeks, rivers, and enclosed bays towards the marine fringe, increasing the size of their home range (Simpfendorfer *et al*., 2010).

Sawfish show a circumtropical distribution that was presumably once continuous in suitable habitat (CITES, 2007; Faria *et al*., 2013). However, this is now severely fragmented with many populations considered to be locally extinct from large parts of their former ranges, while remaining populations are seriously depleted (CITES, 2007). Sawfishes are particularly vulnerable to rapid population declines and possess a low recovery potential because of their large size, unusual body shape, slow growth, late maturity, few offspring and long life span (Walker, 1998; Stobutzki *et al*., 2002). In addition, they live in vulnerable coastal and riverine habitats that are affected by anthropogenic habitat degradation and loss, and pollution (Seitz and Poulakis, 2006). Globally, the largest driver of sawfish decline is bycatch mortality (Seitz and Poulakis, 2006; Burgess *et al*., 2009), though another significant driver is the international trade in sawfish parts – particularly the fins (Clarke *et al*., 2007). Sawfish fins are a particularly high value status symbol in Chinese society (Bell *et al*., 2004).

The majority of research on sawfish comes from the USA and Australia (Peverell, 2005; Thorburn *et al*., 2007; Simpfendorfer *et al*., 2008, 2010, 2011; Wiley *et al*., 2008; Carlson and Simpendorfer, 2014) and is supplemented by a few discrete studies from some other parts of their distribution, namely: Lake Nicaragua (Thorson, 1976), West Africa (Robillard and Séret, 2006), Fiji (Duffy *et al*., 2011) Guinea-Bissau (Leeney and Poncelet, 2013) and the Arabian Gulf (Moore, 2014). Beyond this, however, our understanding of the status of sawfish species is constrained by deficient data. Given their migratory nature, high extinction risk, and the multiple reasons for their decline, rapid assessments of their exploitation and status in data-poor regions of the world are urgently required (Simpfendorfer, 2000; Dulvy *et al*., 2003; Carlson *et al*., 2013). The Indian Ocean is a region of particular neglect and the current study aims to address this by summarizing exploitation and status of sawfishes in Bangladesh and surrounding waters.

Sawfish in Bangladesh

Bangladesh has many key sawfish habitats; it is a flat country with many riverine and estuarine environments and the largest mangrove ecosystem in the world, the Sundarbans (Pasha and Siddiqui, 2003). However, this mangrove forest is in decline at a rate of $6.7\,km^2\,yr^{-1}$ owing to conversion to shrimp aquaculture and illegal woodcutting (Islam *et al*., 2011; Cornforth *et al*., 2012). With fewer tree roots to bind the sediments, riverbanks are becoming more and more vulnerable to accelerated erosion, while a natural reduction of fresh water flow during winter increases salinity (Islam *et al*., 2011). Illegal poison fishing and the use of unauthorized fishing gears are the main anthropogenic threats to the aquatic fauna of Sundarbans (Debnath, 2009). Furthermore, during the monsoon, damage is escalated due to the number of intense cyclones (Islam *et al*., 2011). High and largely unregulated fishing activity takes place in near-shore and offshore areas, to feed the World's eighth-largest human population and to trade with neighbouring India (Islam and Haque, 2004; CIA, 2013). While all species of sawfish in

Bangladesh are protected by the 'Wildlife (Preservation and Security) Act 2012' and Bangladesh is a signatory to CITES, the lack of monitoring and management of fisheries suggest this legislation is poorly enforced and insufficient. For example, fishing takes place in the channels of the Sundarbans, which is the most suitable habitat for juvenile sawfish (Simpfendorfer *et al*., 2010) and Chittagong is considered to be a major trade route for shark fins to Asian markets (Bikram Roy, Chittagong Marine Fisheries Survey Management Unit, pers. comm.).

Encounter records (dating from 1782–2011) from the National Sawfish Encounter Database (compiled by the Florida Museum of Natural History) show zero encounters in Bangladesh and only two recorded encounters in India (http://www.flmnh.ufl.edu/fish/sharks/sawfish/regional.html). However, Quddus and Shafi (1995) recorded the occurrence of two sawfish species in the Bay of Bengal, and according to A. K. A. Rahman *et al*. (2009) three sawfish species have been recorded from Bangladesh. The word 'sawfish' has appeared only once in peer-reviewed literature that is specific to Bangladesh – in Hoq (2009), which listed *Pristis pristis* (formerly *Pristis microdon*, Faria *et al*., 2013) as a threatened species. Roy *et al*. (2010) conducted a study that assessed shark, skate and ray landings at Cox's Bazar and Chittagong in 2006–2007, and recorded three small (68–76 cm) sawfish (all *Anoxypristis cuspidata*) in more than one year of landings data.

The current status of Bangladesh sawfish – including threats, historical declines, range contractions, and current abundance – is completely unknown. While there are many potential threats to sawfish and their habitats, there is no baseline on which to compare future data and to assess the effectiveness of conservation efforts. As such, this present work provides the first historical and current account of sawfish exploitation in Bangladesh, including the Sundarbans mangrove forest and the Bay of Bengal. It aimed to establish: (a) the identity of sawfish species in Bangladeshi waters, (b) their general status, (c) specific areas where sawfish are encountered and remnant populations remain, (d) a qualitative estimate of long-term trends of decline, (e) patterns and trends in sawfish exploitation and other threats, (f) the values of sawfish to local people, and (g) recommended conservation measures specific to the country, as well as the national and international situation regarding policy and environmental law as they relate to sawfish. In this regard, the study can serve as a model for other nations where there are poor data on sawfish.

This study was initiated by the chance sighting of sawfish rostra on sale for medicinal use at a local market at Boiddomari Bazaar, Chandpai Range, Sundarbans in late 2011 by two of the authors, providing an observation that sawfish parts were still being traded in Bangladesh. The work coincided with the IUCN Shark Specialist Group's initiative to develop a Global Sawfish Conservation Action Plan.

METHODS

A national-level rapid assessment of sawfishes was conducted using a combination of archival data sources, site visits, and social research methods. It was considered impractical to apply quantitative methods (e.g. catch analysis, recording measurements at landing sites) to ascertain the current abundance and distribution of sawfish because the existing literature suggests they are very seldom caught (Quddus and Shafi, 1995; A. K. A. Rahman *et al*. (2009); Roy *et al*., 2010). In addition, because there is no known established market for trade in sawfish parts (trade is illegal), data on price and trade routes using market data were unobtainable.

Study area

Specific study sites within Bangladesh were selected on the basis of those locations most likely to lead to the discovery of sawfish and other sawfish related information, particularly major cities and coastal areas: Dhaka, Barisal, Chittagong, Cox's Bazar and Sundarbans. All field trips were made between December 2011 and November 2012. Study sites are shown in Figure 1 (also see Supplementary Tables S1 and S2).

Field visits

Field visits were made as follows: Sundarbans buffer-zone villages[1] (five villages), Dubla Island

[1]The Bangladesh Sundarbans is a protected reserve, but villages line the perimeter and major rivers in an area called the buffer zone.

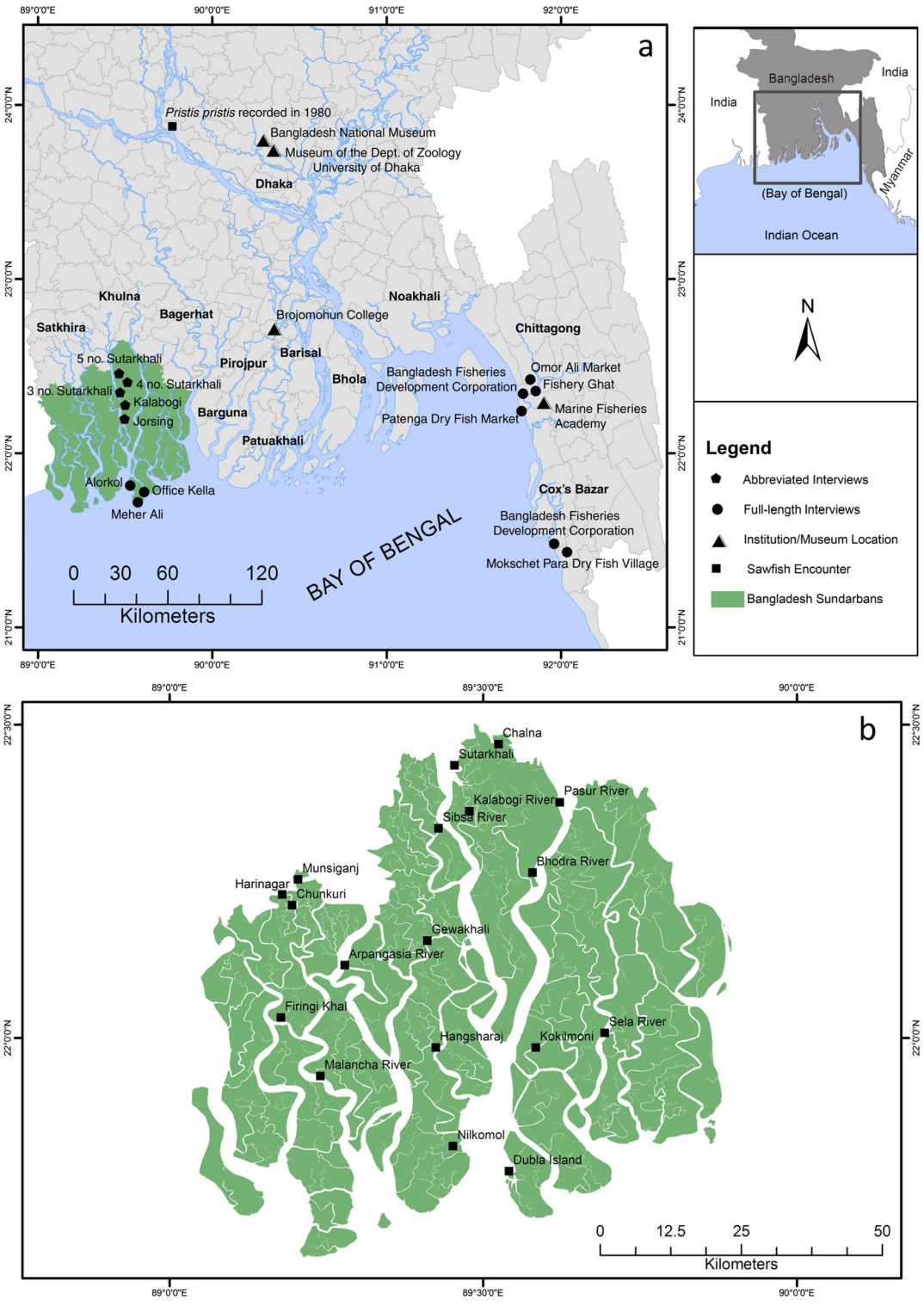

Figure 1. (a) Map of Bangladesh with study locations: non-random full-length interviews with fishers, traders, and national specialists (circles); random abbreviated interviews (pentagons); museums or institutions that have museums (triangles); and one sawfish encounter (square) – the only encounter from outside the Sundarbans that could be precisely plotted. Only museums, institutions, and fish markets that returned sawfish and/or rostra data are included, for the full list see Tables S1 and S2. (b) Enlarged map showing sawfish encounters (squares) within the Sundarbans. Number of reported encounters: waters around Dubla Island (29), Pasur River (19), Firingi Khal (8), Sibsa River (6), Chalna (4), all other locations (<4).

(three villages), Chittagong (five fish landing stations and five fish markets) and in Cox's Bazar (one fish landing station, one dry fish market, and one fishing village), see Figure 1 and Table S2. Fish markets (wet and dry) and *Ghats* (fish landing stations) in Chittagong and Cox's Bazar were explored for the possibility of discovering sawfish and new contacts. A shark fin market (Omor Ali market) was also visited in Chittagong, because sawfish parts (e.g. fins) are often considered to be of similar value and possess similar morphology to those of other sharks. Fins belonging to fish traders that were being preserved ready for export were photographed and related information was recorded. Fish villages from Sundarbans buffer-zone villages, Dubla Island, and Cox's Bazar were visited for the possibility of inspecting captured sawfish and collecting other related data.

Seven museums were visited to search for preserved sawfish and rostra. Private collectors were also identified through existing contacts revealing other individuals that owned other collections. Rostra from public and private collections were measured and photographed and other available information such as approximate date of collection, size of sawfish, name of gear in which the sawfish became entangled, was recorded. Eight academic/research institutions were also visited in a bid to find archive/unpublished data (Figure 1 and Table S1).

Non-random full-length interviews with specialists

Semi-structured interviews were used to collect in-depth qualitative data through asking open questions and facilitating a discussion with 19 national specialists at the country's major fisheries institutions. These specialists included academics and scientific officers involved in active fish research, directors of the institutions, museum curators, and a fish processing technologist. In addition, to gather knowledge regarding the medicinal uses of sawfish, a gentleman who appeared to be the only known medicine maker was also interviewed. Specialists were contacted first over cell phone and then visited for interview. Face-to-face interviews lasted between 30 min and 2 h depending on the availability of the individual. In circumstances where a face-to-face interview was not possible (e.g. due to time or locational constraints, or the sensitivity of the individual – as in the case with the medicine maker), the interview took place over the phone. At the end of the discussion, respondents were asked if they knew anyone else who could contribute information about sawfish.

Non-random full-length interviews with fishers and traders

Information provided by national specialists, along with previous studies (Robillard and Séret, 2006; Wiley and Simpfendorfer, 2010) that used questionnaires to elicit sawfish encounter data from the public, helped in the design of the questionnaire. This was piloted to check for suitable content and question relevance. The final iteration (Supplementary Information, S3) contained three sections. Section A established respondent information (whether they were a fisher or trader, what gears they used, target species, size of boat and crew, where they fished). Section B was a recall survey that asked respondents to recollect and estimate the total number of sawfish that they had encountered[2] during three different timeframes: (a) since the respondent had started fishing (within their fishing lifetime), (b) within the last five years, and (c) within the last year. For each of these timeframes, the annual mean was calculated for each respondent as follows: the number of sawfish encountered since the respondent had started fishing was divided by the number of years that they had been fishing for; the number encountered in the last 5 years was divided by five; and the number encountered in the last 12 months did not require further calculation. Actual means were calculated. The data were then log transformed using log10 to denote the variability of the sample. The number 0.5 was added to every value in the dataset because there were some zero values. Finally, the means of the logged data were back-transformed, and compared with the actual means. Section B also elicited information about the respondent's last sawfish encounter (i.e. species, length and weight, location, date); the main locations and seasons in which sawfish were encountered; gear types that were known to cause sawfish entanglement; and

[2]We define 'encounter' as: the observation of a sawfish, which may or may not include its capture.

threats to sawfish. Section C elicited information about trade and public perception: sawfish sale prices; the geographic direction of trade in sawfish parts; opinions on the medicinal properties of sawfish parts; and general perceptions about sawfish.

Quantifiable questionnaire data were elicited from three regions: Dubla Island, Chittagong, and Cox's Bazar. Respondents included general fish traders, traders that engage predominantly in shark processing and marketing, and a variety of fishers. Most fishing activity in Bangladesh involves artisanal fishers deploying gears from rowing and mechanized boats. Commercial trawling accounts for just 5% of total marine production (IPAC, 2010), while recreational fishing is negligible. Fishers could be grouped into five categories: (a) set-bag net fishers,[3] (b) drift gill net fishers targeting *Hilsa* (*Tenualosa ilisha*),[4] (c) large-mesh gill net fishers targeting sharks,[5] (d) long-line fishers,[6] and (e) commercial trawl fishers.[7] For comprehensive descriptions of these fishing activities, and other gears not listed here see Islam and Wahab (2005), Hoq (2009), and IPAC (2010).

Respondents were selected opportunistically. At times this process involved snowball sampling – whereby respondents are asked to suggest another person whom it would be beneficial to speak to (Overton and van Dietman, 2003). Snowballing was important because we were interested only in individuals who had actually encountered a sawfish, allowing us to get the largest possible number of respondents within a short time-frame – because fishers knew (better than ourselves) which of their connections had or had not encountered sawfish. In keeping with this point, before starting the questionnaire, a large sawfish image (printed on laminated paper) was shown to each respondent to ensure that they were actually talking about the fish shown. Owing to their unusual appearance and relatively large size, sawfishes are easily recognized and remain a memorable experience for those who encounter them, making them a good study species in this regard (Dulvy and Polunin, 2004; Seitz and Poulakis, 2006; Lavides *et al*., 2009; Wiley and Simpfendorfer, 2010). Interviews were conducted face-to-face and one-to-one, lasting between 20 and 30 min. Before starting the questionnaire, respondents were assured of complete anonymity, and given an overview of the project, explaining why their answers were important. While many of the questions were closed, respondents were nonetheless encouraged to go beyond the confines of these questions if they had a strong opinion or something of particular interest to declare. Respondents were occasionally prompted in order to facilitate the narrative, and to double-check responses.

Random abbreviated interviews with fishers and traders

In addition to the full-length interviews conducted in Dubla Island, Chittagong, and Cox's Bazar, shortened versions were conducted with fishers in the Sundarbans Buffer Zone Villages. These were conducted at the end of a different fishing survey that was unrelated to this sawfish research, and hence, full-length questionnaire surveys were impractical because of the time constraints of respondents. As such, at the Sundarbans buffer zone villages, it is important to note that respondents were selected randomly, i.e. unlike at the other three locations, some respondents may never have encountered a sawfish. The shortened version consisted of section A, and then asked respondents if they had ever encountered a sawfish (at which point the laminated photo was shown), and if they had, information on the most recent encounter only was elicited (e.g. the time and location at which it was encountered, estimated length and weight).

[3]Resembling trawl nets, set-bag nets are deployed from rowing boats, and target anchovies, ribbonfish, bombay ducks, clupeids – especially during the pre-monsoon and monsoon. Estuarine set-bag nets are deployed at <10 m, have mouth diameters of 6–15 m, and a legal minimum mesh size of 30 mm. Marine set-bag nets have larger mouths and mesh sizes and are deployed at <30 m. Both are highly destructive and yield high volumes of bycatch including turtles and stingrays (Hoq, 2009). Set-bag nets are one of the most widely used gears in Bangladeshi waters.

[4]The *Hilsa* fishery is the largest single-species fishery in Bangladesh (Mome *et al*., 2007), comprising some 280 000 artisanal fishermen (Mohammed and Wahab, 2013). *Hilsa* fishers deploy drift gill nets at 20–40 m. This gear is banned in Sundarbans but legal in other inshore areas and offshore. Like sawfish, *Hilsa* migrate from marine to brackish water to spawn. This usually occurs during the pre-monsoon and monsoon seasons – and is met with an increase in fishing effort between March and October.

[5]Shark fishers typically deploy large mesh gill nets at depths <30 m.

[6]Long-lines are deployed at 10–30 m and involve 400–800 hooks weighted with bricks (IPAC, 2010). Long-line fishers typically target catfish and croakers.

[7]Commercial trawl fishers target shrimp and fish (including pomfret, croakers, and catfish) offshore, with minimum mesh size restrictions of 45 mm and 60 mm respectively. Trawling is restricted to depths >40 m, but often occurs in waters >20 m deep (Islam, 2003).

RESULTS

Findings from social research methods

Questionnaire respondent profile

In total, 136 full questionnaire surveys were completed from Dubla, Chittagong and Cox's Bazar, plus an additional 67 shortened versions from the Sundarbans buffer zone villages, representing 203 questionnaire respondents in total. All respondents were involved in fishing activities. Some 168 persons were directly involved in fishing, 26 were involved with fish trading, and nine did both. The fishing experience of respondents varied from 5–60 years. The majority of the fishers (n = 150) used a boat with an engine, although five respondents owned a modern trawling vessel, and 22 owned a manually driven boat (*dingi*) – the remainder were traders, see Table 1 for respondents per study region.

Local sawfish names

Different local names of sawfish were found during the questionnaire survey. Most people called sawfish *Karati Hangor* because of its saw-shaped rostra (*karat* is 'saw' and *hangor* is 'shark' in Bengali); other local names included *Khotok*, *Aissya*, *Karati Baila*, *Chepta Hangor*, *Faissya Hangor*, *Faissya*, *Thot Faissya*, *Kankot*, *Khorkot*, and *Ayin Mach* – dependent on the geographical region. These names are all unique to sawfishes.

Results from full-length interviews with fishers and traders

The following three subsections present results from only the 136 respondents interviewed at Dubla Island, Chittagong and Cox's Bazar.

Table 1. The number of questionnaires completed in each of the four study regions and the distribution of questionnaires among two different occupations, fishers and traders

Study region	Sundarbans villages	Dubla Island	Chittagong	Cox's Bazar	All regions
Fishers	67	35	35	31	168
Traders	0	11	6	9	26
Both	0	7	1	1	9
Total	67	53	42	41	203

Sawfish encounters over time

Estimated lifetime encounters per individual varied by two orders of magnitude: some fishers had never encountered a sawfish, while one person claimed to have encountered about 2500 in over 40 years of fishing. There was a weak positive correlation (+0.34) between the number of years that individuals had been fishing, and the number of sawfish that they had encountered during this 'lifetime' of fishing.

Ultimately, the lifetime encounter mean of 3.7 (back-transformed mean = 1.3) sawfish declined to a mean encounter rate of 1.5 (back-transformed mean = 0.4) sawfish per year for the last 5 years, and declined further to a mean of 0.7 (back-transformed mean = 0.3) sawfish encountered in the last year (Figure 2(a)).

Taking only capture data (a subset of encounter data – which also includes observations), on average fishers had caught 1.2 (back-transformed mean = 0.5) sawfish per year in their lifetime; a value that has declined to 0.3 (back-transformed mean = 0.2) sawfish per year for the last 5 years and also 0.3 (back-transformed mean = 0.2) sawfish over the last year. There is a strong seasonal pattern to sawfish captures with most sawfish (67%, n = 91) caught in winter (November–February) when the water levels are lowest, followed by summer (March–June) (18.4%, n = 25). There was a large variation in the weights of caught individuals: 40.4% (n = 82) said 0–20 kg, 11.3% (n = 23) said 20–100 kg, 20.2% (n = 41) said +100 kg, while 28.1% (n = 57) could not remember the weight.

The overall reduction in sawfish populations has reached a point that three fishers stated they had not encountered a sawfish in over 25 years. One-third (n = 45) of respondents had not encountered any sawfish for the last 5 years. The following recollection comes from an elderly fisher at Cox's Bazar: 'I used to go fishing with my father – there were numerous giant sawfish that time, enough to destroy our boat, massive in weight, about 550 kg (13.5-14.0 mon; local metric, 1 mon = 40 kg), entangled in the net. We pulled them to the bank and they were sold at a very cheap rate. Everything has gone now. I have not seen even a baby for 20 years.'

About half (52.2%, n = 71) of the fishers perceived their preferred habitat to be offshore,

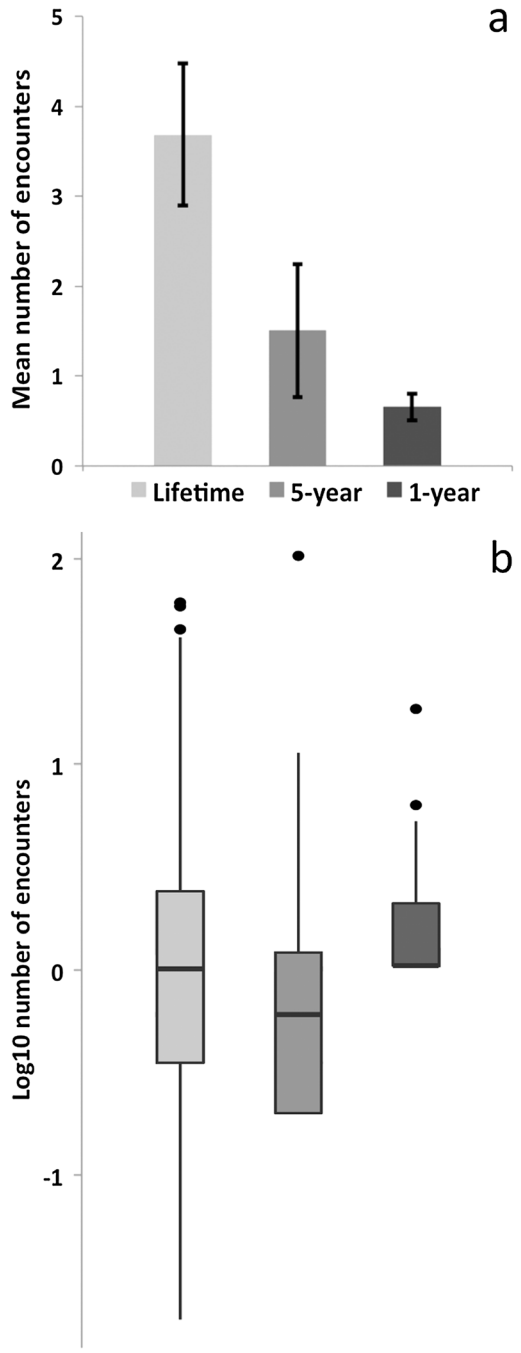

Figure 2. (a) Bar chart displaying mean annual encounter rates (actual values) with standard error bars, for the three time spans. (b) Boxplot of log10 encounter data displaying the spread of the bulk of the data and outliers (highest reported encounter rates) that lie beyond 1.5 times the interquartile range. NB Backtransformed means as given in the text are not shown on (a) or (b), these calculations were made separately.

though the remaining half (47.8%, n = 65) considered inshore to be most preferred. Most of the sawfish (76%, n = 103) that were caught in shallow water were juveniles. Sawfish were always reported to be caught as bycatch and retained for sale.

Perceived threats to sawfish

Almost all (93.9%, n = 78) respondents from Chittagong and Cox's Bazar and half (50.9%, n = 27) from Dubla Island stated that they perceive sawfish to be 'heavily declining' and the remainder thought sawfish numbers were 'declining'.

Some 47% of respondents could not provide any reason for the decline (n = 64). Of the 53% of respondents that could, overfishing in both inshore and offshore areas was the most commonly stated reason (n = 72, i.e. every person that stated a reason for the decline gave at least this one). Other reasons were: less reproduction and growth (n = 10), increased deep sea fishing by intruding foreign boats (n = 7), increased trawl fishing (n = 6), the body shape of sawfish (increased likelihood of entanglement in fishing nets) (n = 4), rise of sandbars (n = 3), people's indifference to obeying fishing laws (n = 3), and juveniles not being thrown back (n = 1).

All respondents were able to explain which gears typically catch the most sawfish – even those within the 47% that did not necessarily perceive overfishing as a reason for the decline. Of all the gears deployed, the monofilament drift gill net was believed to catch the most sawfish as bycatch (83%, n = 113). Of the three versions of monofilament drift gill net that are commonly used, standard gill net (*Fash Jal*) was considered most destructive for sawfish (47% of respondents), followed by the small-mesh shark net (*Nakua Jal*) (20%), and standard shark net (16%). Other gears included set-bag net (13%), trawl net (2%), and long line (2%).

Public perceptions of sawfish

Of the 136 respondents interviewed from Dubla Island, Chittagong and Cox's Bazar collectively, 85.2% (n = 116) of people perceived sawfish as non-threatening, with 14.8% fearing them because of the dangerous saw. However, all respondents (n = 136) of these three regions thought sawfish were useful in some

way. The capture of smaller juveniles is not seen as significant in terms of market value, however, catching a big sawfish creates a stir among rural people who often gather to see the landed sawfish and take pictures and videos. The television media has covered such stories on occasion.

Results from abbreviated interviews with fishers and traders

In the Sundarbans buffer zone villages, where questionnaire respondents were not selected based on whether they had or had not seen a sawfish, some 79% (n = 53 of 67) of fishers had encountered a sawfish during their lifetime. The mean time of last encounter was 6.5 years ago. The most recent reported landing was from one respondent who had seen a 5 kg sawfish landed in Munshiganj one month before being interviewed.

Length–frequency data

From the 203 respondents interviewed, estimated total lengths were elicited for 157 sawfish. Mean estimated total length was 2 m. For encounters <5 years ago and >5 years ago, mean estimated total lengths were 1.8 m (n = 102) and 2.4 m (n = 55) respectively (Figure 3).

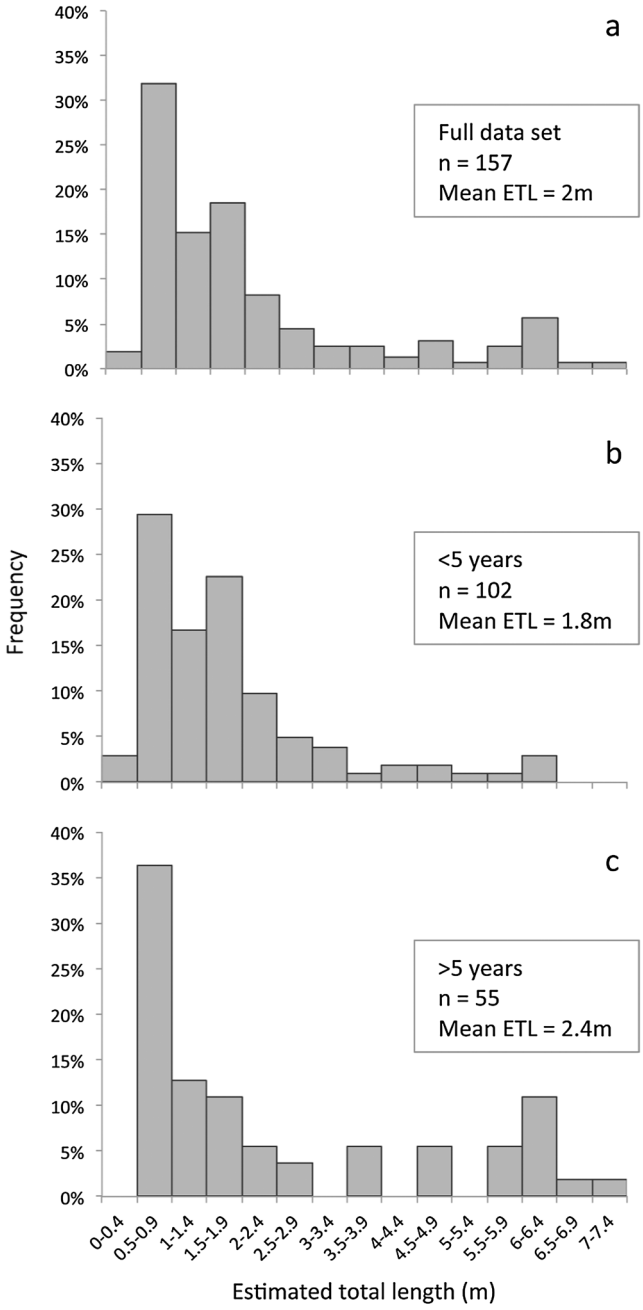

Figure 3. Frequency distribution of estimated total lengths of sawfish from 157 reported encounters in Bangladesh: questionnaires (n = 153), museum specimens (n = 3), and field sightings (n = 1). Out of 203 questionnaire respondents, 36 could not estimate the length of the sawfish, and 14 had never seen a sawfish. Data arranged for (a) all reported encounters, (b) encounters <5 years ago, (c) encounters >5 years ago. Species are only likely to be *Anoxypristis cuspidata* and *Pristis pristis* (individuals >3.5 m are only likely to be *P. pristis*).

Findings from field visits

Dry fish markets and villages

Dry fish play a vital role in the livelihood of fishers in coastal areas (especially the south-east and south-west regions of the country). During winter, seasonal fishers engage themselves in fish drying. As such, the probability of finding dried sawfish increases. A fish trader from Mokschet Para dry fish village, Cox's Bazar, presented a 35-cm-long caudal fin and two dorsal fins (20 cm and 17 cm long) from a large sawfish that had been caught in Chittagong in January 2012. The structure of the caudal fin indicates that this was *P. pristis*. This could indicate that fish traders have a direct link between Chittagong and Cox's Bazar. The trader said the rostrum was still in Chittagong. No details on its purchase or selling price were shared.

Four other dry fish markets (Chaktai, Nimtola, Riyaj Uddin, and Patenga) were visited in March 2012 (summer) to determine the presence of dried sawfish, but none were found on the day they were visited.

The largest dry fish shop in Patenga, Chittagong named, 'Bismillah Shutki Ghar', had 180 items of dry fish (different fish species) for sale. The owner said, 'We are not keeping sawfish because this fish is prohibited (haram) to eat by Muslims, and hence there is no demand – but we are able to provide it if pre-ordered.' In Dubla, there were reports (n = 4) that sawfish may still be used in the Muslim community for medicine.

Ghats, landing stations

Ghats are good locations for acquiring actual data of fishes being caught by the fishers. A large juvenile sawfish, *P. pristis* was landed at Cox's Bazar on 18 November 2011 and measured in the field: weight 82 kg, total length 218 cm, saw length 71 cm (Figure 4). The sex was not determined. Dr Shahabuddin, chief scientific officer at BFRI, Cox's Bazar said, 'this is the only big individual of this species recorded since 1999 in Cox's Bazar.' Fishermen sold this sawfish to a fish trader for US$375; the trader then sold the finless (two dorsal fin and caudal fin were removed) sawfish with its rostra to a man for US$175 who bought this fish to make medicine.

Two juvenile *P. pristis* were landed in Cox's Bazar on 29 April 2012; both were measured in the field. The first one was 94 cm in total length and 2.15 kg in weight. The second one was 132 cm in total length and 4.78 kg in weight. These two individuals were sold at a similar price to more common food fish species, typically tk. 50–150 per kg.

Figure 4. *Pristis pristis* landed in Cox's Bazar: whole individual, total length 218 cm (top) and amputated fins (bottom).

The price of sawfish varied greatly. Ultimately, price depends on the size of the sawfish. Particularly, larger fin sizes determine greater export value. Muscle was sold at prices between US$1.25 and US$2.5 per kg, saw prices varied from US$3.75–18.75 depending on size, and fin prices ranged from US$3.75–$937.50 depending on size. The highest prices were typically offered for fin sizes >20 inches. Dried sawfish fins were sold at about US$6.25 per kg. The price-range of all whole-bodied sawfish sales identified by this investigation varied between US $37.5 and US$1375.

Preserved specimens and rostra

Sawfish specimens and information was found at four of the seven museums visited (Table S1). Three preserved specimens (one juvenile *P. pristis* and one juvenile *A. cuspidata* preserved for educational purposes, and an adult *P. pristis* on public display at the Bangladesh National Museum, Dhaka) and an additional 12 sawfish rostra were recorded from museums and three were recorded in the field (Table 2). Of these 15 sawfish rostra six belonged to *A. cuspidata* and nine belonged to *P. pristis*. Furthermore, information on another six privately owned rostra was recorded remotely (via cellphone) but no length measurements were given and their existence could not be verified.

Unpublished data

An unpublished fishing record of sharks, skates, and rays landed at various stations between July 2010 and June 2011 was collected from BFRI, Cox's Bazar. This 12-month record lists 53 sawfish: length range 59–147 cm; mean length 83 cm; weight range 12.8–104 kg; mean weight 17.2 kg. These individuals were all landed between November 2010 and April 2011 (i.e. the Bangladeshi winter). Sawfish made up 0.096% of total recorded landings by weight. All sawfish had been mistakenly classified as '*Pristis cuspidatus*', so the exact species of each individual (*P. pristis* or *A. cuspidata*) could not be inferred. These sawfish were not included in Figure 3 because only a length range was given – rather than each individual being listed with its corresponding length.

Table 2. Details of sawfish and rostra preserved in public and private collections and identified in the field. All observations were made in 2012

Source/owner	Capture location	Capture date	Rostral[1] / Total[2] Length (cm)	No. of rostral teeth on left/right side	Notes from sources
Zoology Department Museum, University of Dhaka	***Pristis pristis*** Meghna River	1919	122[1]	17/17	Approximate length of this sawfish was 5 m.
Marine Fisheries Academy	Bay of Bengal	1968	150.5[1]	18/17	This was 1500 kg in weight and it gave birth to 37 embryos after it was caught.
Bangladesh National Museum, Dhaka	Jamuna River	1980	580[2]	17/17	This sawfish has been displayed to the public in the Bangladesh National Museum. At the time of dissection 32 embryos were recovered from the uterus of the mother fish.
Brojomohun College, Barisal	Kuakata	1993	96[2]	17/17	This juvenile sawfish was preserved for educational purpose. Its rostral length is 25 cm.
Captain of Modern Trawl Fishing Vessel	Bay of Bengal	1995	119[1]	17/18	Approximate length of this sawfish was 5 m and weight might be 500 kg.
Brojomohun College, Barisal	Kuakata	1998	162[1]	17/17	
Brojomohun College, Barisal	Kuakata	1998	110[1]	18/17	
Brojomohun College, Barisal	Kuakata	1998	26[1]	14/15	
Zoology Department Museum, University of Dhaka	Unknown	2002	24[1]	16/17	
Shark fin trader of Omor Ali Market	Bay of Bengal	2004	124[1]	17/18	Trader stated that sawfish have 'vanished', and that only one or two appear per fishing season. Barguna (south-western region) was suggested as a place in which to find sawfish.
Shark fin trader of Omor Ali Market	Karnaphuli River mouth ***Anoxypristis cuspidata***	2009	60[1]	17/17	Trader stated that sawfish are declining and are very rare now. Patuakhali, Barisal (southern region) was suggested as a place in which to find sawfish.
Brojomohun College, Barisal	Kuakata	1998	39[1]	30/29	
Brojomohun College, Barisal	Kuakata	1998	34[1]	28/29	
Marine Fisheries Academy	Bay of Bengal	2000	62[2]	30/30	This juvenile sawfish was preserved for educational purpose. Its rostral length is 20.5 cm.
Zoology Department Museum, University of Dhaka	Unknown	2000	50 + [1]	25+/24+	This rostrum is damaged at its tip.
Zoology Department Museum, University of Dhaka	Unknown	2001	75[1]	29/27	Collected by Professor MMA Quddus, Department of Zoology, University of Dhaka.
Zoology Department Museum, University of Dhaka	Unknown	2002	37[1]	29/28	
Zoology Department Museum, University of Dhaka	Unknown	2002	48.5[1]	30/30	

Medicinal value and trade

Sawfish are mainly sold whole, although some respondents (n = 48) preferred to sell only the muscle and/or fins; fins were considered to be the most useful parts and commanded a high market price (US$ 937.5 for two dorsal and a caudal fin; local exchange rate 1 US$ = 80 taka, as of May 2013). In addition, the liver was said to be a good source of Vitamin D (n = 2); the saw was used for ornamental displays on living room walls (n = 6); the fats/oils were used as a source of multiple vitamins (n = 13), while the vertebrae were used for medicinal purposes (n = 4). Talisman vendors (n = 7) in the Sundarbans Buffer Zone Villages sold sawfish vertebra and claimed that wearing a piece around the waist cured waist pain. In addition, two talisman vendors in Dhaka selling amulets made from the vertebrae of a variety of marine species (described as 'shark, sawfish, and dolphins'), claimed they not only cured 'all types of disease' but also 'protect the wearer from all kinds of evil harm'.

Two-thirds (66%, n = 35) of respondents from Dubla Island considered sawfish to have medicinal value. Of those, almost half (48.6%, n = 17) believed sawfish cured cancer: 'Oh, you are searching for anti-cancer fish', was the first remark of a fisher's leader from Dubla Island, when shown the sawfish image before interview. Another fisher of the same village informed us that ceratotrichia ('fin-vein') is useful as operational stitching, as this thread is later absorbed by the body, and promotes the natural healing of wounds. However, in the large cities of Chittagong and Cox's Bazar, only 12% (n = 10) of people believed sawfish had medicinal value, while the remaining respondents (88%, n = 73) were unaware of such properties demonstrating regional variation in the cultural value of these fishes. A number of other diseases thought to be curable using sawfish are listed in Table 3.

The large sawfish landed on 18 November 2011 in Cox's Bazar, was bought for US$175 (minus the two dorsal and the caudal fins which were reportedly sold separately for an unknown price) by a medicine maker from Barguna, a south-western district. According to this medicine maker, sawfish muscle is used to produce medicine primarily to cure cancer, but also to treat gangrene, accelerate wound healing and soothe ulcers. He also used powdered rostra and stated that, 'every part of the sawfish has medicinal value'. The medicine maker estimated that 20–50 of his patients had recovered using sawfish medicine.

DISCUSSION

This is the first systematic survey of sawfish exploitation and status in Bangladesh. Sawfish populations around the world are dramatically declining (Stevens *et al*., 2000; Cavanagh *et al*., 2003) and this study demonstrates this is also the case in Bangladesh and surrounding waters.

Species

The survey confirms that two sawfish species are present in Bangladesh, *P. pristis and A. cuspidata*, with the former being relatively more abundant. The presence of *P. pristis* and *A. cuspidata* within the waters of Bangladesh verifies what has been reported in the limited number of previous studies (Hoq, 2009; A. K. A. Rahman *et al*. (2009); Roy *et al*., 2010). Some museum tags suggested the presence of *P. perotteti* (typically found in Atlantic waters) in Bangladesh, but this species has now been synonymized with *P. pristis* following publication of a new taxonomy (Faria *et al*., 2013).

It had been thought that sawfish brood sizes range from 1–13 for *Pristis perotteti* (now *Pristis pristis*) (Thorson, 1976) and from 6–20 for *Anoxypristis cuspidata* (http://www.flmnh.ufl.edu/fish/Gallery/Descript/KTSawfish/KTSawfish.html). However, some museum tags belonging to specimens included in the current study reveal that brood sizes of *Pristis pristis* can be as many as 32 or even 37 (Table 2), which is much larger than any previously published study on sawfish.

Other sawfish species (*P. zijsron* and *P. clavata*) may be, or once have been, present in Bangladesh waters, but this could not be confirmed within the scope of this study. The absence of these species from written records, museum and private collections, and fish markets suggests they are either

Table 3. Human diseases thought to be cured by using sawfish parts

Disease name	Parts used	Source
Cancer	Muscle	All Dubla inhabitants
Heart disease	Muscle	Fishing leader, Alorkol, Dubla
Arthritis	Vertebra, Fat	Fishing leader, Alorkol, Dubla
Kidney disease	Muscle	Fishing leader, Alorkol, Dubla
Tuberculosis	Muscle	Fishing leader, Alorkol, Dubla
Anaemia	Liver, Fat	Fishing leader, Alorkol, Dubla and Chittagong
Influenza	Liver, Fat	Fishing leader, Cox's Bazar
Tonsil problem	Muscle, Fat	Fishing leader, Cox's Bazar
Waist pain	Vertebra	Fishing leader, Alorkol, Dubla and Cox's Bazar
Operational stitch	Ceratotrichia	Fishing leader, Majher kella, Dubla
Gangrene	Muscle with herbs	Medicine maker, Barguna
Wound healing	Muscle with herbs	Medicine maker, Barguna
Ulcer	Muscle with herbs	Medicine maker, Barguna

extinct in Bangladeshi waters, extremely uncommon, or may never have frequented this region.

Distribution

Sawfish are distributed throughout the coastal waters of Bangladesh, including: the Sundarbans, Dubla Island, Khulna, Pirojpur, Bagerhat, Patuakhali, Barguna (Patharghata), Barisal, Mohipur, Alipur, Khepupara, Chittagong and Cox's Bazar. Most inshore encounters occurred in channels and rivers within or directly adjacent to the Sundarbans, particularly the Firingi *Khal* (eight encounters reported) and Pasur River (19 encounters reported). There was, however, one exception: museum records indicate that in 1980, one large pregnant sawfish (now on public display in the Bangladesh National Museum, Dhaka) was caught from the Jamuna River, which flows through northern Bangladesh, some 300 km inland from the Bay of Bengal (see Table 2). Such behaviour has been reported elsewhere, with *P. pristis* found 1340 km inland within the Amazon basin (Thorson, 1974).

Despite the rostra of *P. pristis* and *A. cuspidata* being morphologically different, respondents were unable differentiate between these species – probably because sawfish are encountered so infrequently that this and other morphological differences are too subtle to notice. This makes it difficult to determine the relative distribution and abundance of the two species based on the questionnaire survey, and highlights the need for fin clips or vertebrae samples to be collected whenever possible.

Respondents were in agreement that most sawfish (67%) are encountered in the Bangladesh winter (November–February), a finding that corroborates the unpublished fishing records collected from BFRI, Cox's Bazar. In winter, the water becomes more saline and the water level is lower due to low levels of rainfall. The lower water level may make sawfish more susceptible to fishing. However, this peak can more likely be explained by increased fishing effort, as this is the season when there is the highest fishing activity – particularly for fishers targeting *Hilsa*.

Population declines

Based on questionnaire findings it is clear that these fish were formerly relatively abundant in Bangladesh, similar to other parts of the world such as West Africa (Robillard and Séret, 2006) and Indian River Lagoon System, Florida (Snelson and Williams, 1981). However, sawfish are now rapidly declining in Bangladeshi waters. Some fishers had not seen a sawfish in over a quarter of a century.

Encounter data are inherently biased in a variety of ways (e.g. participation is voluntary) and are not by their nature collected in scientifically standardized ways (e.g. randomly, every year, from same gear sources). As such, using it to infer abundance estimates or population trends over short time scales is not possible, and the approach has only been used here to infer long temporal trends. The encounter data elicited here have a non-normal distribution and spread across three orders of magnitude (Figure 2(b)). Both the actual mean (Figure 2(a)) and back-transformed mean show a clear decline – at least between the lifetime mean and 5-year mean. The lack of congruence between the 5-year mean and 1-year mean arises because of the high variance in both estimates, meaning that no significant difference between the two estimates emerges. Most questionnaire respondents (77%) described the animals as 'heavily declining'; it is noted that shifting baseline syndrome may have had an effect on the perceptions of decline among some respondents. These findings suggest that at present, one sawfish is typically landed at each major landing station (in Cox's Bazar, Chittagong and Dubla Island) per month.

Overfishing threat

Overfishing in both inshore and offshore areas was the principal cause of sawfish decline. While sawfish are not targeted, they are particularly susceptible to bycatch through entanglement of their rostra in the net. Out of all the gears deployed, the drift gill net was believed to catch the most sawfish as bycatch, akin to other studies (Simpfendorfer, 2000; Stevens *et al.*, 2005; Heileman and Scott, 2008). This is the most widely used gear in offshore areas, but is also used in the Sundarbans despite it being banned (Serajuddin and Rahman, 1999; IPAC, 2010). Other fishing-related threats cited by respondents were: increased deep-sea fishing by illegally intruding foreign boats, increased trawl fishing disturbance,

and juveniles not being thrown back when caught. Sawfish were also thought to be naturally becoming less reproductive and not growing as large, which could link to other issues such as a lack of food, or capture before they reach full size. Further studies are required to establish the actual impacts of these observed threats and their significance.

The majority of sawfish reported from landings data during this investigation were sexually immature juveniles suggesting that they were inshore catch (Simpfendorfer *et al.*, 2010, 2011; Poulakis *et al.*, 2011). The 53 sawfish recorded by the BFRI ranged in size from 59–147 cm (mean 83 cm). In addition, the questionnaire data showed that 40.4% of those who had caught a sawfish said that the weight of the most recent individual caught was <20 kg. Finally, historical data showed that three *A. cuspidata* landed in this region in December 2006, were all juveniles (68–76 cm total length) (Roy *et al.*, 2010). This relative abundance of juveniles suggests that the inshore fishing areas serve as an important juvenile habitat for sawfish species of Bangladesh (Simpfendorfer *et al.*, 2010, 2011; Wiley and Simpfendorfer, 2010). It also indicates that the numbers of sexually mature individuals could be very low. If juveniles are killed before becoming mature, recruitment to the adult stock will reduce, meaning that the population could eventually become extinct.

Habitat threat

Most of the sawfish in Bangladesh were reported to occur mainly in rivers and estuarine habitats, particularly in Sundarbans. As such, threats to mangroves in the Sundarbans e.g. sedimentation and changes in water levels (Siddiqi, 2001; Islam and Wahab, 2005; Wahid *et al.*, 2007; M. M. Rahman *et al.*, 2009; Lewis *et al.*, 2011) are likely to adversely affect sawfish, as has been reported elsewhere (Simpfendorfer, 2000; Seitz and Poulakis, 2006). Some fishers stated that upstream development projects (such as the Farakka Barrage) reduce freshwater flow from the north. Reduced water flow increases sedimentation and brings about rising sand bars in the coastal area. These sand bars may limit how far sawfish can migrate upstream to breed, reducing access to critical nursery habitat.

Medicinal value and trade threat

A major conservation challenge is that sawfish are a valuable bycatch and so are rarely released. This value stems first from the local beliefs of rural villagers that sawfish possess healing properties, and second from the fact that sawfish fins and suitably large individuals can be exported for great financial reward to the Chinese market for use in Traditional Chinese Medicine (usually via city traders). Such uses have been reported elsewhere (Thorson, 1982; McDavitt, 1996; Fowler, 1998). While national law prohibits any export/import of wildlife without an appropriate certificate from CITES, the observations and data from interviews suggest that sawfish (particularly fins) are still being exported, with the predominant trade routes from either Cox's Bazar or Chittagong to China. Bangladeshi shark fin traders stated that they are not facing any authoritative check by border control, that officials often succumb to bribery, and (whether truthfully or not) that they are unaware the law prohibits sawfish trade – and as such, both fishers and traders need to be made fully aware of such regulations. In addition, during one field visit to Cox's Bazar, two Chinese shark-fin buyers visiting Bangladesh were identified but refused to engage in conversation; most city-traders were reluctant to divulge information. This suggests that not all border authorities are well versed with CITES, and regardless, no specific punishments are outlined for killing or exporting sawfish (unlike for tigers, deer, cetaceans and many other animals). As such, provision(s) should be added in the existing Wildlife (Preservation and Security) Act 2012 stating appropriate punishment for any damage to 'Schedule I and II' listed species.

Sawfish conservation

In Bangladesh, the Forestry Department are responsible for fisheries within the Sundarbans, while the Department of Fisheries are responsible for aquatic resources within all other national boundaries. A number of fisheries management regulations involving gear restrictions, access limitations and controls on catch have been proposed since 1989 although many of these are yet to be implemented (Hoq, 2009). Furthermore, those that

have been implemented are not necessarily enforced fully (Rouf, 2001), and during the questionnaire survey it became apparent that fishers are often neither aware of, nor comply with, these regulations. The monofilament drift gill net is considered to be the most problematic gear type, not just for sawfish but also for most other aquatic life (Haque, 2003; Mansur *et al*., 2008). Use of this gear is illegal in Sundarbans, but legal elsewhere. The survival of sawfish in Bangladeshi waters will depend upon stricter regulation of gill nets and other destructive fishing activities, coupled with proper implementation of existing legislation. However, the overlapping bureaucracy poses a significant challenge to conservation efforts; the current institutional arrangements for conservation and management are inadequate owing to in-fighting between departments, and their reluctance or insufficient capacity (i.e. manpower) to effectively enforce laws on the ground; for example, the number of boat patrols conducted by the Forest Department in Sundarbans is thought to be inadequate (Rouf, 2001; Islam, 2003). Corruption is also a problem (Islam, 2003); some respondents explained that creating more laws would simply create more opportunities for the authorities to take bribes. Traditional management tools in Bangladesh tend to be designed and imposed using a 'top-down' approach (Hussain and Hoq, 2010), but it is clear that stakeholder engagement and public support are necessary to implement sustainable fisheries management that increases survival of sawfish and aids in the recovery of sawfish populations, so that biological goals may be aligned with socio-economic needs (Syakur *et al*., 2012).

Since most sawfish are caught alive, there is scope to develop a conservation initiative to release these individuals unharmed, as is practised in the USA and Australia (NMFS, 2009). Many fishers, particularly those at Dubla Island, are illiterate and uneducated (MARC, 1995) and have little knowledge of how their fishing activities might be threatening the environment or certain species. A targeted outreach programme could be a valuable mechanism to increase awareness of the threats to sawfish and seek behaviour change, primarily to release live sawfish. Widespread awareness campaigns have been used in the Indian Sundarbans (Sarkar and Bhattacharya, 2003). These are typically voluntary and the scale of effort required in this case may require funding and technical support from NGOs. In Bangladesh, *Hilsa* fishers that adhere to fishing laws are currently eligible to receive non-financial incentives such as rice (Mohammed and Wahab, 2013). Since these fishers typically deploy drift gillnets, there could be scope to integrate a sawfish release scheme into the existing agreement. However, while fishers could be better motivated to release (potentially valuable) live sawfish with a similar or financial incentive, verification of such actions would be difficult to attain.

It is widely reported in the literature that juveniles prefer shallow coastal and mangroves habitats (Whitty *et al*., 2009; Simpfendorfer *et al*., 2010; Wiley and Simpfendorfer, 2010), and the same theme emerged from discussions with national specialists and the residents of fishing communities. The Sundarbans mangrove forest – probably the most important nursery for juvenile sawfish in the Bay of Bengal – is a UNESCO World Heritage site, and entry is only permitted by boat. Seasonal permits are issued to honey collectors allowing them to enter on foot, while wrong-doers will typically only take risks to poach deer, rather than cut trees. As such, the forest itself is relatively safe from direct deforestation. However, a mounting conservation challenge is posed by upstream development projects such as the Farakka Barrage in India (which is located just 16 km from the Bangladesh border). Such damming activities alter water flow, and subsequently salinization, erosion, sedimentation, ecological production, and human livelihoods. This was mentioned by some respondents in this study, and has recently been highlighted as a growing threat in other deltaic systems such as the Greater Mekong basin (WWF, 2013). The future construction of dams, must be subject to full ecological impact assessments, and involve regional consultation and cooperation, particularly with India. Such activities threaten sawfish directly, by reducing their access to upstream pupping areas, and indirectly by affecting the long-term presence of Sundarbans. While mangrove habitats are under threat in Bangladesh (Hoq, 2009; M. M. Rahman *et al*., 2009; Manna *et al*., 2010), sawfish may be a useful flagship or umbrella species to focus conservation efforts.

Fishers could not provide precise locations where the sawfish were encountered, and rather gave the location of the nearest village in Sundarbans, or the name of a major river or well-known channel. As such, the data collected here were not detailed enough to infer potential range reductions and areas where remnant populations remain – although reported encounters in Sundarbans were not concentrated in any particular location (Figure 1(b)). We recommend the future collection of detailed data on sawfish distributions (for different species and life stages), which may allow remnant populations to be identified. This could lead to the proposition of sanctuaries to protect these areas of relatively high sawfish occurrence. Such sanctuaries have already been proposed for the Ganges River dolphin and Irrawaddy dolphin in the Sundarbans (BCDP, 2011).

The status of sawfish populations in Bangladesh and surrounding waters is one of long-term decline (predominantly due to the widespread use of drift gill nets and other non-selective fishing gears), and exploitation by way of a reluctance to release live sawfish bycatch because of the local belief that these fish possess medicinal properties, and that larger specimens command a high price on the Chinese market. If conservation measures – specifically (a) effective implementation of national fishing and wildlife trade laws, and (b) fishers being educated as to the importance of releasing sawfish bycatch – are not put in place then the population declines inferred from these encounter data should be expected to continue. Bangladesh has a growing coastal population, and the already-high fishing pressure in Bangladeshi waters is expected to increase (Islam and Haque, 2004; Hoq, 2009), potentially exacerbating the situation.

The outcomes and recommendations outlined in this study can be used to inform conservation management decisions in Bangladesh as well as in the region. This will require a strengthening of capacity with the Forest Department and Department of Fisheries, NGO support, and an acceptance of existing regulations and outreach initiatives from fishers and traders. Sawfishes are Critically Endangered species, but with more rapid assessments similar to this one, conservationists will be in a better position to secure their long-term recovery. The approach used here can be usefully applied to other regions where there are poor data on sawfish. This timely first assessment of sawfish in Bangladesh enhances our previously limited understanding of the species' status and exploitation in this region of the world, and highlights opportunities for immediate conservation action.

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