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Fishers' perceptions of the performance of hilsa shad (*Tenualosa ilisha*) sanctuaries in Bangladesh

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ABSTRACT

A sanctuary is a specific form of protected area and considered to be an important management measure for the conservation and management of fisheries resources. Using socioeconomic and biological indicators, this study investigates the perceptions of fishers towards sanctuaries that were established in the rivers of Meghna and Padma and in inshore waters of Bangladesh since 2005 to protect the declining hilsa (*Tenualosa ilisha*) populations. Both qualitative and quantitative data were collected from six communities adjacent to five hilsa sanctuaries and then analyzed to know the socioeconomic profile of fishers as well as their perceptions of the performance of sanctuaries. The majority of fishers felt that an apparent recent increase in hilsa catch is due to the establishment of sanctuaries. Their perception is well supported by catch statistics that show higher overall hilsa production both from inland and marine waters. However, fishery closure led to substantial economic hardship due to lost income. If the sanctuaries are to function effectively, issues (e.g. lost income) affecting fishers must be addressed by offering compensation schemes so that fishers are able to support their families. The process has to be transparent, inclusive and equitable. There is also a need to support alternative livelihoods for fishers in order to reduce dependence on hilsa fishing. Moreover, fishers must be provided with economic and/or other incentives so as to share responsibilities to protect and manage sanctuaries successfully. Since fishers' involvement is key to the success of sanctuaries, social acceptance of fish sanctuaries by fishers is a must.

1. Introduction

No-take fishery closures,[1] whether permanent, seasonal or temporary, or aimed at protecting target species, placing limits on catches of undersized fish, or controlling specific gear, are among the oldest type of fishery management tools (Ward et al., 2001). Fisheries sanctuaries are particularly important for protecting critical habitats and reducing targeted fishing effort on spawning aggregations (Kincaid et al., 2014; Leleu et al., 2012). Therefore, closure of specified areas to all forms of fishing/harvesting during active spawning and nurturing seasons can reduce fishing mortality directly (Gruss and Robinson, 2015; Clarke et al., 2015; Murawski et al., 2000). While fisheries sanctuaries are considered to be an effective management tool, they can also negatively affect dependent communities socially, economically, culturally and politically (Jentoft et al., 2012; Mascia et al., 2010). For example, closed areas often tend to displace or marginalize subsistence fishers and bring them economic hardship by squeezing income-generating options (Isaacs, 2011; Pollnac et al., 2001; McClanahan, 1999). Consequently, a lack of community support is a major obstacle in achieving desired success (Kincaid et al., 2014). Community support is shaped by how stakeholders perceive the benefits of sanctuaries. Though fishers' perception is a key indicator of the performance of sanctuaries (Leleu et al., 2012), there are very few studies available (e.g. Mohammed and Wahab, 2013) that have investigated fishers' views on the effects of hilsa sanctuaries. Using a mixed methods approach, this study investigates the perceptions of fishers towards hilsa sanctuaries established in the rivers of

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[1] Fisheries closures, sanctuaries and protected areas are used interchangeably here.

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Meghna and Padma and in inshore waters of Bangladesh.

The hilsa shad (*Tenualosa ilisha*) constitutes the largest single-species fishery of Bangladesh in terms of catch weight and employment. It contributes 11% of the total fisheries catch, employments for 0.5 million fishers directly and another 2 million people indirectly, and about 1% to GDP (BOBLME, 2012; Mohammed and Wahab, 2013) Anadromous hilsa species migrate from the open sea (i.e. the Bay of Bengal) into inland freshwater system, primarily the Meghna, Tetulia and Andermanik Rivers to spawn (Hossain et al., 2014; Rahman et al., 2014) and subsequently develop into juveniles (locally known as '*jatka*'). To protect the fishery from overexploitation of juveniles, the Government of Bangladesh declared four areas as hilsa sanctuaries in 2005 and a fifth one in 2011. In the sanctuaries, a ban is imposed on catching *jatka* (hilsa <25 cm size) during certain periods of the year. Depending on the occurrence of *jatka* the ban period differs in sanctuaries (see Table 1). In addition, a 15-day closure is imposed during full moons in autumn (October month) to ensure safe breeding of hilsa in all coastal rivers.

The cumulative result of these efforts, as suggested by the catch statistics (FRSS, 2014), has been an increase in hilsa yields over the last few years though there are significant concerns about fishers' loss of earnings. To compensate fishers for restrictions on fishing, the government has given fishers incentives in the form of rice and alternative income generating activities on a limited scale. Studies exist on various aspects of hilsa fisheries of Bangladesh including sustainable exploitation and general management of hilsa, identifying suitable spawning grounds and potential threats to better hilsa management (Hossain et al., 2014; Miah, 2015), and policy formulations with regard to hilsa fishing (Bala et al., 2014). However, there are no studies that have explored the effectiveness of hilsa sanctuary development and its consequences on fishers' livelihoods in Bangladesh. Rather, it has been assumed that interventions related to hilsa sanctuary development have not achieved their desired social success (Rahman et al., 2014; Mohammed and Wahab, 2013). There is therefore a need to undertake a rigorous study to examine the impact of sanctuaries on hilsa fishers. The results of this study are summarized in two sections – *Part 1* explains the perceived biological and social benefits and vulnerabilities of hilsa sanctuaries, and *Part 2* discusses the results of the study in terms of key issues, problems and solutions as perceived of by fishers to overcome the pitfalls of sanctuary development and management.

2. Description of sites and methods

The study was conducted among six communities residing adjacent to the five hilsa sanctuaries (Fig. 1; Table 2). The selected communities were directly dependent on fishing inside the sanctuaries for livelihood earnings from fisheries related activities such as fishing, fish drying, fish trading, net mending, boat making and boat repairing. Part-time fishers engaged in other livelihood activities such as agriculture and day labour during the offseason months of fishing. In Char Atra, respondents were seasonal migrant fishers coming from North Bengal to catch hilsa fish during the peak season. We carried out interviews with these migrant fishers on their boats. In Ramgati Bazar, we interviewed nomad fishers who permanently reside on their boats with their households. In the other four study areas we interviewed fishers either in fish landing sites or on their fishing boats depending on when they fished. The interviewees included boat owners who invested in fishing but did not directly engage in fishing operations and *majhis* who are captains of fishing boats. In a few cases, the boat owner acted as *majhi*. Moreover, fishing crews we interviewed were of two types: i) *vaghis* (boat crews who get a share of the profit) and ii) waged fishing labour. Due to the diverse group of people engaged in hilsa fisheries, a "snowballing" sampling method was used to identify potential fishers to interview next (Bernard, 2006). A purposive sampling approach was employed among the identified individuals to preferentially interview knowledgeable fishers. Only this type of sampling can provide important information from particular settings, persons or events that are deliberately selected (Maxwell, 1997).

Both qualitative and quantitative data were collected. Following the administration of a semi-structured questionnaire, a total of 130 individual interviews were undertaken involving male fishermen. The questionnaires were aimed at collecting information on the respondent's demographic characteristics (age, education, family income, etc.), details of his fishing activity (target species and fishing methods, types of gears, and membership of any organization), fishing experience, level of dependence on fisheries, and their perceptions and attitudes towards hilsa sanctuary management with regard to biological and socioeconomic impacts.

Likert scale responses were used to assess the biological performance and socioeconomic implications of sanctuaries. In addition, a number of relevant data regarding involvement in sanctuary development and present and future management approaches were collected. A total of 24 focus group discussions were carried out in which each group consisted of 9–16 persons and each session took approximately 1.5 h. In addition, 25 key informant interviews were conducted with knowledgeable persons such as fish entrepreneurs, fish traders and local government officials. Key informants were expected to answer questions by virtue of their knowledge and experience. Data obtained from interviews were analyzed using SPSS (Statistical Package for Social Science, Version 16). Data were collected for 6 months from December 2014 to May 2015.

A logit model was applied using STATA 12.0 software to identify the factors influencing fishers' perceptions and attitudes towards the effectiveness of sanctuary development. The basic logit model (Gujarati and Porter, 2009) is described in the following formula:

Table 1
The locations of five hilsa sanctuary areas and the ban period on fishing (Rahman et al., 2011).

No.	Sanctuary area	Ban period
1	A 100 km long stretch in the lower Meghna Estuary; Shatnol (Chandpur) to Char Alexander (Lakshmipur)	March to April
2	90 km in the Shahbajpur River (a tributary of the Meghna River); Madanpur/Char Ilisha to Char Pial (Bhola)	March to April
3	About a 100 km area of the Tetulia River; Bheduria (Bhola) to Char Rustam (Patuakhali)	March to April
4	A 40 km stretch of the Andharmanik River; Kalapara Upazila (Patuakhali)	November to January
5	A 20 km stretch of the Padma River; Lower Padma River at Naria to Bhedarganj Upazila (Shariatpur)	March to April

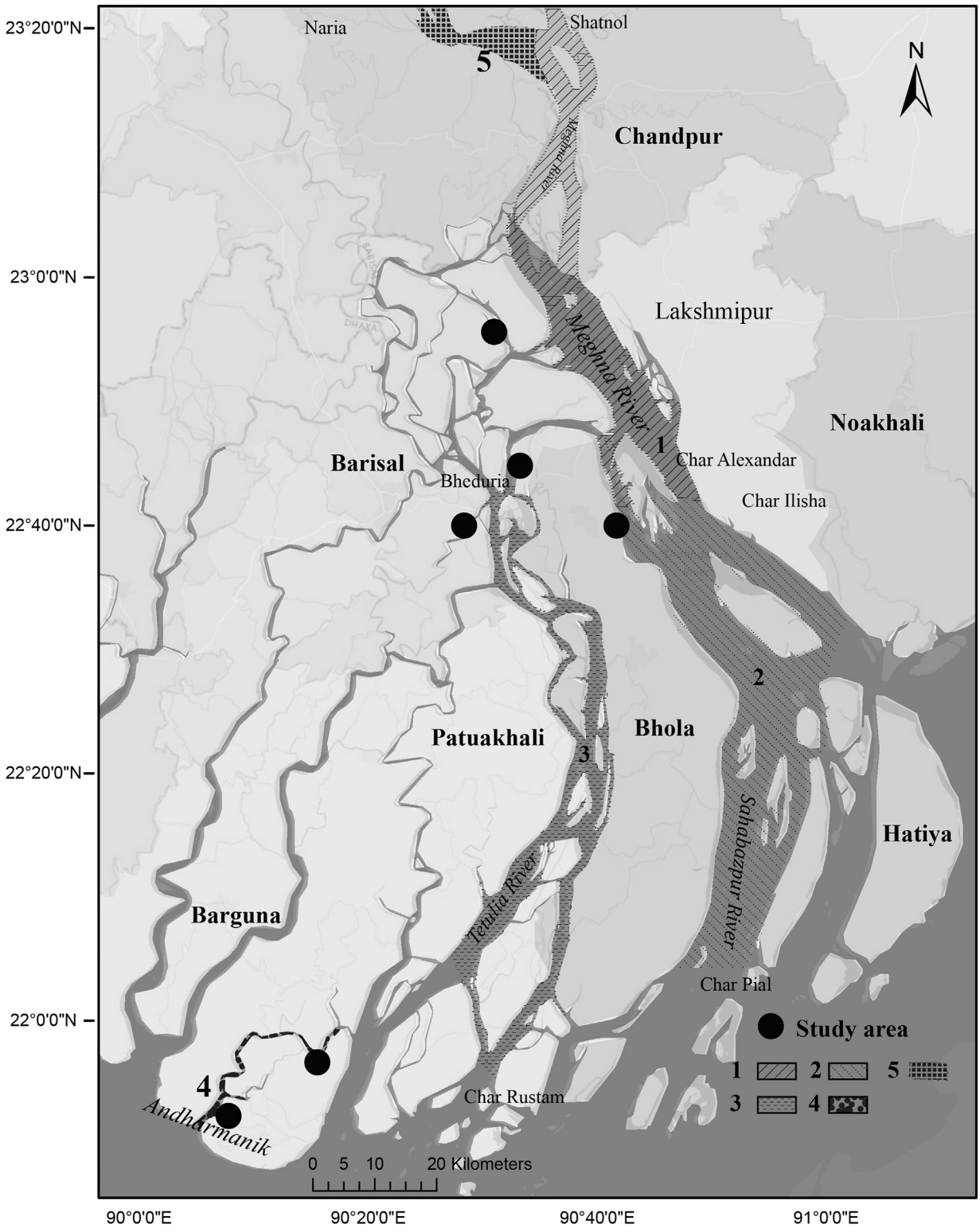

Fig. 1. Map of the study areas adjacent to hilsa sanctuaries. Five hilsa sanctuaries are marked with five different colours. The five round black dots indicate the study areas.

$$\ln\left(\frac{P}{1-P}\right) = a + \sum_{i=1}^{n} \beta_i X_i$$

where P = the probability that an event (whether a sanctuary is good or bad) occurs for an observed set of variables; a = the intercept (constant); β_i = the effect of i^{th} explanatory variable on the probability of having a good or bad effect of sanctuary; and X_i = the explanatory variables (n = 6) namely income, experience, government assistance, organization, length of boat and ownership of boat.

Table 2
Location and characteristics of surveyed fishing villages.

Village (district)	Key economic activity	Distance	Method		
			II	KII	FGD
Fatehpur (Patuakhali)	Agriculture, aquaculture, fishing, rickshaw pulling	Within 1 km of sanctuary four	30	2	4
Laharhat (Barisal)	Agriculture, fishing, aquaculture	Within 1.5 km of sanctuary three	26	3	4
Puraton Hizla (Barisal)	Fishing, small scale business, driving	Within 1 km of sanctuary one	20	2	2
Ramgati Bazar (Lakshmipur)	Fishing	Within 0.5 km of sanctuary two	15	–	–
Char Ilisha (Bhola)	Fishing, agriculture	Within 1 km of sanctuary one	22	1	2
Char Atra (Shariatpur)	Fishing	Within 0.5 km of sanctuary five	17	–	3

(II = Individual Interview; KII = Key Informant Interview; FGD = Focus Group Discussion).

3. Results

3.1. Socioeconomic profile of hilsa fishers

Over one third (37%) of surveyed fishers are illiterate, half of them (49%) attended primary school up to Class V and only 15% received secondary education from class VI to X. Fishing is the main occupation for 96% of respondents and on average fishers have 17 (±8.4) years of fishing experience. The average household size is 6 persons, which is higher than the national average (4.6 persons[2]). A majority of the fishers have their own houses, but fishers of the Char Atra are migrants who reside intermittently in their in their boats while fishers of the Ramgati Bazar follow a nomadic lifestyle and live permanently in their boats. Approximately half the fishers (46%) are involved in a secondary occupation such as day labour and rickshaw/van pulling, mainly during the off-peak fishing season. A typical yearly income of the respondents is BDT 92,980 (USD 1192). The fishers who work as crew earn 8–9000 BDT (USD 103–115) per month. Hilsa is the main species caught by 97% of fishers. Most of the fishing boats are 28 feet long and motorized (81%). Fishers mainly use drift gill nets, set gill nets and monofilament gill nets for hilsa fishing. Nearly 60% of respondents receive assistance from the government during ban periods for fishing *jatka* and brood hilsa. Nearly all (90%) respondents have access to credit, mainly through the informal *'dadon'* credit system (i.e. advance sale of catches) operated by fishing entrepreneurs, or micro-credit from NGOs. Of the total respondents, 63% are members of a social and professional organization such as a cooperative society (Table 3).

3.2. Fishers' perception of the performance of hilsa sanctuaries

3.2.1. The performance of biological indicators

Most fishers (~75%) agreed that hilsa catches have increased to some extent in their fishing zone due to sanctuaries (Table 4). In support of their claim, one fisher from Fatehpur said, *"If hilsa can breed safely, the numbers of fish caught by a single net will certainly increase."* About 17% of fishers responded in a neutral way regarding whether sanctuaries had increased hilsa catches and the remaining 8% disagreed. One key informant explained, "*Hilsa catch is very unpredictable, sometimes even for months fishers don't get enough catch and this kind of situation may lead to the perception that there are no benefits of sanctuaries in terms of total hilsa harvest. If there were no sanctuaries, hilsa might be extinct within the next few decades*." The results of the Chi-square test also suggest that the distribution of fishers' beliefs could not be explained by chance, yet perceptions remained diverse amongst fishers ($\chi^2 = 93.983$, $df = 2$, $p = 0.000$).

Two-third of the respondents pointed to an increase in the abundance of other species, while 10% of respondents dissented with this opinion ($\chi^2 = 61.061$, $df = 2$, $p = 0.000$). Incidentally, ~23% of respondents were irresolute with regard to whether there was an abundance of other species because they might only do hilsa fishing and are not aware of the quantities of other species. A majority of respondents (~73%) agreed that hilsa sanctuaries are important in terms of making their fishing trips profitable ($\chi^2 = 82.661$, $df = 2$, $p = 0.000$). Surprisingly, fishers were undecided about the ecological role of sanctuaries. About 46% of respondents acknowledged the important role of sanctuaries as breeding and sheltering grounds whereas the remaining respondents were irresolute. Only a small percentage of respondents felt that sanctuaries were not important for fish breeding and sheltering. Chi-square tests demonstrated that the distribution of beliefs could not be explained by chance, suggesting the presence of defined, yet diverse perceptions held by the fishers ($\chi^2 = 43.687$, $df = 2$, $p = 0.000$).

3.2.2. The performance of socioeconomic indicators

The respondents, in general, expressed widely positive reactions regarding the conservation benefits of hilsa sanctuaries, but many of them raised concerns about adverse socioeconomic implications on their livelihoods. When asked if there were perceived conflicts of interest between fishers with respect to benefits from the sanctuary, most fishers (~78%) said no while ~14% were irresolute ($\chi^2 = 113.757$, $df = 2$, $p = 0.000$), suggesting mutual respect among members of the fishing community (Table 5). Approximately half of the fishers perceived that hilsa sanctuaries mainly benefit neighbouring coastal waters/ecosystems. However, around 44% fishers were irresolute and around 8% disagreed with the view that benefits only went to neighbouring coastal waters/sanctuaries. Many fishers were frustrated that the added harvest is much less than their lost income. One fisher from the Puraton Hizla (Barisal) area stated, "*After breeding, hilsa fish run away from sanctuaries to open marine waters or even to neighbouring countries, thus we pay the price of lost income while others are getting the benefits*". The chi-square test suggested that the distribution of fishers' beliefs could not be explained by chance, yet diverse perceptions were observed among fishers ($\chi^2 = 31.53$, $df = 2$, $p = 0.000$). Most fishers (~69%) believed that establishing new fish sanctuaries will not lead to any conflicts in the community ($\chi^2 = 79.791$, $df = 2$, $p = 0.000$). Around 63% of fishers assented that sanctuaries negatively affect their fishing income while 34% disagreed ($\chi^2 = 31.53$, $df = 2$, $p = 0.000$). During the fishing ban period, fishers receive 400 BDT (USD 5) daily wages for lost income from fishing. One waged fisher estimated his lost income to be 4000 BDT (USD 10) during the 15 day ban period. Thus, monthly incentives of around 1200 BDT (USD 7) are insufficient to compensate fishers for their loss. The loss is even higher during the *jatka* ban period. The wage of fishing labour did, however, increase from 100 BDT/day before the establishment of the sanctuary in 2005 to the present rate of 400 BDT/day. Though inflation has a role to play, higher demand for labour due to better catch and market price of hilsa is likely to offset inflation several

[2] Sample Vital Registration System, 2010. Bangladesh Bureau of Statistics.

Table 3
Socioeconomic profile of fishers living around the hilsa sanctuary areas.

Variable	Description	Mean (±SD)	Frequency (%)
Age	Age of respondent (year)	35 (7)	–
Education	Illiterate	–	37
	Primary school (class I to V)	–	49
	Secondary school (class VI to X)	–	15
Household composition	Head of household	–	–
	Number of members	6 (2.6)	–
Main occupation	1 → if main occupation is fishing 0 → otherwise	0.96 (0.205)	96
Experience	Number of years of working in the fishing profession (year)	17 (8.4)	–
Income	Respondent's net yearly income	BDT 92,980 (12,410)	–
Secondary occupation	Respondent having Secondary occupation	–	46
Target species	1 → if main target is hilsa fish 0 → otherwise	0.96 (0.185)	97
Fishing craft	Length of fishing boat	28 (8.915)	–
	Power (1 → motorized, 0 → otherwise)	–	81
	Engine power	24.53 (7.53)	–
Govt. assistance	1 → if receive Govt. assistance 0 → otherwise	0.59 (0.494)	59
Access to credit	1 → if respondent has access to credit 0 → otherwise	0.90 (0.295)	90
Organization	1 → if belong to a organization/group 0 → otherwise	0.63 (0.486)	63

Table 4
Perceptions of fishers about biological performance of hilsa sanctuaries.

Likert-scale item	Response (%)						
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Chi-square	*p*-value
The catches of hilsa have increased inside and around the sanctuaries	0.00	7.80	16.50	54.80	20.90	93.983	0.00
Diversity and densities of other fish types have improved in the sanctuary zones	2.60	7.80	22.60	47.80	19.10	61.061	0.00
Sanctuary is an important tool for successful fisheries management	5.20	4.30	17.40	52.20	20.90	82.661	0.00
Sanctuaries are necessary for providing fish habitats and increasing fish reproduction	0.00	4.30	49.60	46.10	0.00	43.687	0.00

Table 5
Perceptions of fishers about socioeconomic implications of hilsa sanctuaries.

Likert-scale item	Response (%)						
	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Chi-square	*p*-value
Sanctuaries have increased conflicts among fishers	47.80	32.20	13.90	6.10	0.00	113.757	0.00
Sanctuaries have only benefitted the coastal ecosystem	0.90	7.80	44.30	47.00	0.00	31.503	0.00
Adding new sanctuaries can lead to conflicts of interest in the community	37.40	31.30	30.40	0.90	0.00	79.791	0.00
Sanctuaries have negatively impacted my income	–	34.30	–	8.70	57.00	31.530	0.00
Sanctuaries have resulted in my household food consumption becoming insecure	–	34.30	–	12.00	53.70	29.470	0.00

key informants suggested.

In response to a question regarding whether hilsa sanctuaries adversely impacted their ability to meet their household food consumption needs, 65% of fishers agreed and 34% dissented ($\chi^2 = 29.47$, $df = 2$, $p = 0.000$). Though it is quite evident that sanctuaries would negatively affects fishers' income due to restrictions placed on them, some fishers said that this is not necessarily the case because they might continue fishing by breaching the law. One fisher from the Char Atra (Shariatpur) said: "*Some fishers earn even better during the ban period as they continue fishing with less competition by giving bribes to the law enforcing agencies*". Many fishers explained that the impacts of fishery closures have extended beyond their households to other associated people who are involved in the fish value chain.

3.2.3. Fishers' perceptions and attitudes towards hilsa sanctuary and management approach

More than 80% of respondents felt that sanctuaries are good, but only a few respondents (4%) had some kind of involvement in the development of sanctuaries (Table 6). The low levels of community engagement were often blamed for the application of a top-down management approach. About 82% of respondents would like to be directly involved in sanctuary development in the future, partly because only 2% trust the government association to undertake overall management of sanctuaries. One fisher from Char Ilisha (Bhola) said: "*Hilsa is not only the asset of government but also of common people, so it is also our responsibility to save the fish*". Fishers believe that a co-management approach involving fishers and government is the possible best management option for operating sanctuaries in a sustainable way. Fishers are skeptical about their

Table 6
Perceptions and attitudes of fishers towards hilsa sanctuary and management approach.

Variable	Yes	No	Chi-square	*p*-value	*df*
Are sanctuaries good?	88.70	11.30	68.88	0.00	1
Fishers' involvement in sanctuary development	3.50	96.50	99.56	0.00	1
Attitude towards involvement	81.70	18.30	46.33	0.00	1
Better management option:					
1) Management by the government	1.70	–	–		
2) Management by both fishers and government	63.50	–	65.86	0.00	2
3) Local community based management	34.80	–	–		

own capacity to manage sanctuaries alone. Hence, the majority of fishers (64%) suggested that both fishers and government should be involved ($\chi^2 = 65.86$, $df = 2$, $p = 0.000$).

3.3. Factors influencing fishers' perceptions and attitudes towards sanctuary development

The results from the logit regression model showed that income of fishers, membership of organization, length and motorization of fishing boat were significant factors in explaining the positive and negative impacts that sanctuaries have on fisheries (Table 7). Around 56% of respondents with yearly income below 100,000 BDT (1285 USD) considered sanctuaries as a negative ($p < 0.05$) initiative. Likewise, fishers who do not own motorized boats also mentioned that sanctuaries have only brought negative consequences to the fisheries ($p < 0.05$). In contrast, fishers who were members of a social organization largely considered sanctuaries as a good initiative by the government ($p > 0.05$). The length of fishing boats (i.e. big size mechanized boats) had an influence on fishers' perceptions in terms of sanctuaries playing a positive role in hilsa production.

4. Discussion

To prevent hilsa catches from declining, the Department of Fisheries implemented the Hilsa Fisheries Management Action Plan (HFMAP) in 2003. The plan included a number of strategies such as a total ban on catching *jatka* and compensation for lost income. Consequently, from 2002 to 2003, the decline of hilsa has been halted. In addition to this hilsa conservation effort, the Government of Bangladesh (GoB) declared four sanctuaries in 2005 that helped increase hilsa production remarkably (Fig. 2). In general, sanctuaries appear to have positive biological impacts, although catch per unit effort (CPUE) data is lacking to assess the exact extent of recovery of hilsa stocks. There are indications that the establishment of sanctuaries has succeeded in stopping the decline of hilsa stock as reflected in the higher catch statistic of overall hilsa production, both from the inland and marine waters of Bangladesh (FRSS, 2014; Mohammed and Wahab, 2013). This data suggests that the tools used for hilsa fishery conservation in Bangladesh are efficacious. At the same time sanctuaries have considerable negative consequences on the socioeconomic status of fishers which could ultimately lead to unintended ecological consequences through social non-compliance (Isaacs, 2011; Mascia et al., 2010; Ostrom, 1990). Respondent fishers showed negative attitudes for a number of reasons towards mismanagement of the incentive scheme. While fishers were chosen for the scheme based on their degree of marginality, many deserving poor fishers were excluded and instead non-fishers were enlisted due to their power and social connections. Rice given to households (~32 kg) was insufficient for average size household. The programme also provides no cash support to fishers to buy other daily necessities or meet health and educational expenses of children. Given that hilsa fishers are generally poor (see Islam, 2011; Rahman et al., 2014), not providing them with adequate alternative livelihoods and compensation would mean that sanctuaries make them worse off. Sanctuary closures hinder their access to fisheries resources that are critical to their livelihoods. Thus, fishers on a low income band consider sanctuaries to cause misery to them. Though increased hilsa production leads to higher economic output of the fishery as a whole, this output does not readily benefit all hilsa fishers, particularly not poor fishers as their wages do not change immediately due to higher harvests. In a desperate move to earn income, many fishers continue fishing during the ban period often by using fine-meshed, destructive gear such as monofilament gill nets, locally known as '*current jal*'. Consequently, they face penalties such as imprisonment and confiscation and seizure of their fishing gear by law enforcing agencies. Due to the relatively small sample size of this study, one cannot assume that the findings reported are representative of the situation in all communities living around hilsa sanctuaries. However, a few other studies have pointed to similar conclusions in terms of the impact of sanctuaries on hilsa fishers (Rahman et al., 2014; Mohammed and Wahab, 2013).

In the present study, the majority of fishers held conservationist views, and appreciated the management and conservation initiatives aimed at protecting the hilsa fishery upon which they depend. However, as they depend on this fishery for their livelihoods, their self-interested behavior is often contrary to conservation goals. In

Table 7
Logit model estimating the factors influencing fishers' perceptions of and attitudes towards an effective sanctuary development. Number of observation = 110, LR chi^2 (7) = 36.90, Prob > chi^2 = 0.000, Log likelihood = −21.509, Pseudo R^2 = 0.462, Coefficient = Index function for probability. The bold values indicate statistical significance at the $\alpha = 0.05$ level.

Variable	Mean	Coff.	Odds ratio	SE	Z	$P > \|z\|$
Income (1 → if yearly income <BDT 100,000 or USD 1,285; 0 → otherwise)	0.43	−2.85	0.06	1.14	−2.51	**0.012**
Experience (1 → if fishing experience <10 years; 0 → otherwise)	0.74	−2.23	0.11	1.23	−1.82	0.069
Government assistance (1 → if respondent gets assistance; 0 → otherwise)	0.59	−0.04	0.96	0.90	−0.05	0.960
Organization (1 → if respondent is a member; 0 → otherwise)	0.63	3.58	35.86	1.16	3.09	**0.002**
Length of boat (feet)	24.24	−0.05	0.95	1.90	2.27	**0.023**
Ownership of boat (1 → if own non-motorized boat; 0 → otherwise)	0.18	−2.97	0.05	1.15	−2.59	**0.009**
Constant	–	4.33	75.74	1.90	2.27	0.023

(Coff. = Coefficient; SE = Standard error).

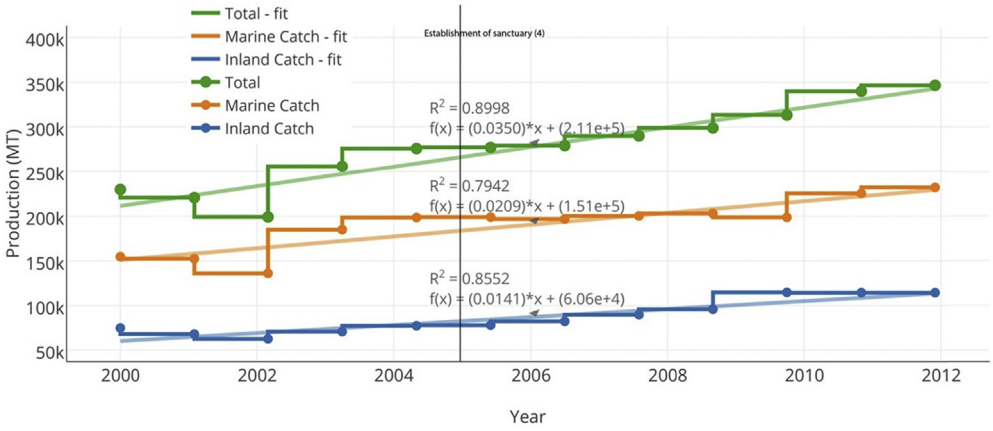

Fig. 2. Trends in hilsa catch in the inland and marine waters of Bangladesh. Data collected from 2000 to 2012. Production measured in metric tonnes per year (Source: FRSS, 2014).

fact, the loss of rights to fish in sanctuaries has resulted in increased poverty, indebtedness, non-compliance and hence, criminalization among fishers. Rahman et al. (2014) observed that 14.7% of the surveyed households who continued with hilsa fishing year-round, violating the ban are indebted to '*dadon*'. Recently, from November 2014 to May 2015, the government organized 639 mobile courts and 1651 drive operations in the five sanctuary areas to enforce their legal authority. The government seized 131.836 metric tonnes of *jatka* and 644,07,380 m of fishing nets, filed 320 criminal complaints against fishers, penalized fishers to the order of BDT 14,73,700 (USD 18,655) for breaches, and imprisoned 93 violators (DoF, 2015).

Given this situation, it was important to investigate the factors that influence fishers' attitudes to protected areas and their social costs to see whether they will be supportive of conservation initiatives. Fishers' perceptions regarding the performance of sanctuaries both in biological and socioeconomic terms are divided, i.e. fishers did not feel that hilsa sanctuaries are either uniformly 'good' or uniformly 'bad" (Mascia et al., 2010). A number of factors, particularly the socioeconomic characteristics of fishers, were found to influence perceptions in a multitude of ways. For instance, motorization and size of boats are an important indicator of greater economic capability: fishers without motor boats who usually are poor consider sanctuaries to be bad as the ban period seriously hampers their daily income. Half of the respondents also felt that sanctuaries did not result in ecological benefits. The reasons may be that fishers are uninformed about scientific knowledge of undisturbed places for hilsa breeding. Access to such knowledge is presumably related to education levels, age and experiences of fishers.

Fishers who belong to a organization, such as a cooperative, are inclined to consider the establishment of sanctuaries as a positive move by the government. Such an attitude is related to the fact that members of social organizations may be outspoken and/or involved in management. Thus, they receive relevant knowledge and feedback on sanctuaries, and also find the opportunity for social interactions with other stakeholders. Inclusion of fishers in local social organizations, as a means of co-management through government support, will therefore be helpful in making conservation efforts successful. Fishers, in fact, suggested that they be included in the process of management with shared responsibility for hilsa sanctuaries. It is suggested that legitimacy of conservation efforts can be strengthened by ensuring increased participation of local people, including fishers, in management so as to realize better socioeconomic and ecological outcomes (Bennett and Dearden, 2014). Thus, conservation success is highly dependent on delegating responsibilities to communities (Pita et al., 2010; Jentoft and McCay, 1995; Ostrom, 1990). This type of restructuring can produce multiple benefits for the existing hilsa sanctuary management system. Firstly, as sanctuaries exist in high population density basins, resident fishers can easily watch/patrol these areas (Salas et al., 2007). Fishers' participation is expected to reduce enforcement costs of government. Secondly, if fishers and other stakeholders in the value chain, such as fish traders, are to shoulder responsibility of managing sanctuaries, they are less likely to violate the conservation regulations. For these reasons, the engagement of all stakeholders in monitoring and policing activities should be considered, along with a compensation scheme, if required (Mohammed and Wahab, 2013).

The compensation scheme should take into account the average household size of fishers and their dependence on the fishery so as deter non-compliance. Inclusiveness should be emphasized and the process of beneficiary selection must be transparent. Weak enforcement of laws and regulations is another major reason for non-compliance (Anderson and Lee, 1986) and thus appropriate logistic support must be given to the Department of Fisheries. Moreover, Bangladesh shares the hilsa fish stock with bordering countries such as India and Myanmar, both of whom do not prohibit fishing during ban period of hilsa fishing in Bangladesh. Respondent fishers mentioned that free riders from neighbouring countries need to be regulated. This highlights the need for transboundary cooperation and joint exploration and conservation of resources in the Bay of Bengal.

5. Conclusion

The establishment of sanctuaries is an important attempt to manage the single most important hilsa fishery in Bangladesh. Though there is a lack of sufficient scientific data to evaluate the efficacy of sanctuaries, some data obtained from surveys based on fishers' perceptions exists. Fishers have a wealth of indigenous knowledge and experience that can be integrated into the decision-making process to help improve the performance of sanctuaries (Dalton, 2005). This will also allow fishers to be part of the learning process vis-à-vis sanctuary management. If fishers have a negative view towards sanctuaries, they are likely to be unsupportive, and that may reduce the effectiveness of sanctuaries. Indeed, the perceptions of fishers in the present study have important implications for implementing or revising management plans of established hilsa sanctuaries.

While fishers are largely positive about sanctuaries and their role in conserving biodiversity, they have lost out on income and livelihoods. Poor fishers should not have to shoulder such a burden.

Hilsa fishers need to be involved in the management process in order to make conservation efforts successful. As such, adoption of a co-management mechanism will help to ensure the legitimacy of conservation measures, improve governance performance, and potentially change dissident fishers' perceptions towards sanctuaries. Involving the poor especially is important because they cannot forfeit their livelihoods and food security needs as they living on the margins of subsistence. They need to be compensated for their loss and sacrifice. Most fishers are supportive and hold positive views of the conservation/ecological benefits of sanctuaries. They are also willing to abide to fishing regulations/bans. But to make the sanctuaries more successful, various social welfare and local level social development programmes should aim to create new economic opportunities for fishers and their families.

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