BALANCING CARROTS AND STICKS

Incentives for sustainable hilsa fishery management in Bangladesh

Nadia Dewhurst-Richman, Essam Yassin Mohammed, Md Liaquat Ali, Kaisir Hassan, Md Abdul Wahab, Zoarder Faruque Ahmed, Md Monirul Islam, Annabelle Bladon, GC Haldar, Chowdhury Saleh Ahmed, Mihir Kanti Majumder, Md Mokammel Hossain, Atiq Rahman and Belayet Hussein – 2016

SHAPING SUSTAINABLE MARKETS

BCAS

iied

First published by International Institute for Environment and Development (UK) in 2016

http://pubs.iied.org/16619IIED
ISBN: 978-1-78431-334-0

For further information please contact: International Institute for Environment and Development (IIED), 80–86 Gray's Inn Road, London WC1X 8NH, United Kingdom.
www.iied.org/pubs

Citation
Dewhurst-Richman N, Mohammed EY, Ali ML, Hassan K, Wahab MA, Ahmed ZF, Islam MM, Bladon A, Haldar GC, Ahmed CS, Majumder MK, Hossain MM, Rahman A and Hussein B (2016) Balancing carrots and sticks: incentives for sustainable hilsa fishery management in Bangladesh. International Institute for Environment and Development, London.

Designed by
SteersMcGillanEves
01225 465546

Laid out by
Regent Typesetting
www.regent-typesetting.co.uk

Printed by
Full Spectrum
www.fullspectrumpm.co.uk

Cover photo
Hilsa fish at a market in Barisal, Bangladesh.
Photo by Finn Thilsted.

Edited by
Holly Ashley

Series Editor
Emma Blackmore

Shaping Sustainable Markets
Shaping Sustainable Markets is the flagship research project for the Sustainable Markets Group at IIED. Can markets be 'governed' to better benefit people and planet? This project explores the individual and combined impact of market governance mechanisms on sustainable development to find out what works where and why. Some of these mechanisms are well established. Others are innovative ideas yet to be tested in the real world.

We want to improve and broaden understanding of how market governance mechanisms can be designed and used to secure livelihoods and protect environments. Find out more about our work at shapingsustainablemarkets.iied.org.

We welcome your comments on this publication or other aspects of Shaping Sustainable Markets. Please contact emma.blackmore@iied.org.

Disclaimer
This paper represents the views of the authors and not necessarily those of IIED.

Acknowledgements
The authors acknowledge the financial support of Defra (UK) for funding the Darwin-Hilsa project through a joint consortium of IIED, Bangladesh Agricultural University (BAU) and Bangladesh Centre for Advanced Studies (BCAS). Special thanks are given to the Darwin-Hilsa research team of BCAS and BAU for their active support in the implementation of the research and to Syed Arif Azad, Director General, Department of Fisheries, Bangladesh for his continuous inspiration, sincere interest and support towards the implementation of the research activities. Finally, the enthusiasm and sincere support from the officials of the Department of Fisheries at the field level, as well as at headquarters, are gratefully recognised.

Funding for this research comes from UK aid from the Department for International Development and Defra's Darwin Initiative. However, the views expressed do not necessarily reflect the views of the UK government.

About the authors
Nadia Dewhurst-Richman, freelance research consultant specialising in Bangladesh fisheries.

Essam Yassin Mohammed, senior researcher, Sustainable Markets Group, International Institute for Environment and Development (IIED), London. Corresponding author email: eymohammed@iied.org

Md Liaquat Ali, senior fellow, Bangladesh Centre for Advanced Studies (BCAS).

Kaisir Hassan, assistant director, Department of Fisheries, Ministry of Fisheries and Livestock, Bangladesh.

Md Abdul Wahab, team leader, EcoFish^{BD}, WorldFish, Bangladesh.

Zoarder Faruque Ahmed, professor, Department of Fisheries Management, Bangladesh Agricultural University (BAU).

Md Monirul Islam, associate professor, Department of Fisheries, University of Dhaka.

Annabelle Bladon, PhD student, Imperial College Conservation Science research group.

GC Haldar, monitoring and evaluation specialist, Project Implementation Unit (PIU), Bangladesh Agricultural Research Council (BARC), Dhaka.

Chowdhury Saleh Ahmed, fellow, BCAS.

Mihir Kanti Majumder, chairman, Rural Savings Bank, Bangladesh.

Md Mokammel Hossain, former director general, Department of Fisheries, Bangladesh.

Atiq Rahman, executive director, BCAS.

Belayet Hussein, senior programme manager, BCAS.

About the partners
The Bangladesh Centre for Advanced Studies (BCAS) is an independent, non-profit and non-governmental policy, research and implementation institute working on sustainable development at local, national, regional and global levels. It was established in 1986 and has grown to become a leading research institute in the non-governmental sector in Bangladesh and South Asia.

Established in 1961, the Bangladesh Agricultural University (BAU) is the premier seat of higher agricultural education and research in the country. The missions of BAU have been to develop the art and science of agriculture for the well-being of mankind and to educate agriculturists to high standards of scientific, managerial and professional competence in harmony with the environment, and to share knowledge and skills with world partners.

BALANCING CARROTS AND STICKS

Incentives for sustainable hilsa fishery management in Bangladesh

Nadia Dewhurst-Richman, Essam Yassin Mohammed, Md Liaquat Ali, Kaisir Hassan, Md Abdul Wahab, Zoarder Faruque Ahmed, Md Monirul Islam, Annabelle Bladon, GC Haldar, Chowdhury Saleh Ahmed, Mihir Kanti Majumder, Md Mokammel Hossain, Atiq Rahman and Belayet Hussein – 2016

FIGURES

TABLES

BOXES

ACRONYMS, ABBREVIATIONS AND INITIALS

AIGA	Alternative income-generating activities
BAU	Bangladesh Agricultural University
BCAS	Bangladesh Centre for Advanced Studies
BCCT	Bangladesh Climate Change Trust
BCCRF	Bangladesh Climate Change Resilience Fund
BDT	Bangladeshi taka (national currency)
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
CBD	Convention on Biological Diversity
CTF	Conservation trust fund
DC	Deputy Commissioner
DoF	Department of Fisheries, Ministry of Fisheries and Livestock (MoFL)
FAO	Food and Agriculture Organization of the United Nations
FDR	Fair dividend rate
FGD	Focus group discussion
GDP	Gross domestic product
GSI	Gonadosomatic Index
HCF	Hilsa Conservation Foundation
HFMAP	Hilsa Fisheries Management Action Plan
IIED	International Institute for Environment and Development
MoFL	Ministry of Livestock and Fisheries
MPA	Marine protected area
PES	Payments for ecosystem services
UFO	Upazila (sub-district) Fisheries Officer
REDD+	United Nations programme for reducing emissions from deforestation and forest degradation
UNO	Upazila Nirhabi Officer
UPC	Union Parishad (council) Chairman
UPIC	Union Project Implementation Committee
VGF	Vulnerable Group Feeding Programme

FOREWORD

Bangladesh is one of the major fish-producing countries in the world. In terms of global fish production, in 2014 Bangladesh was ranked fourth and fifth in inland-capture fisheries and aquaculture production according to the UN's Food and Agriculture Organization (FAO 2014). Fisheries play a vital role in the economy of Bangladesh. The sector contributes about 3.7 per cent to GDP and more than 2 per cent to export earnings. Fish provides more than 60 per cent of the animal protein in people's diet in Bangladesh and approximately 11 per cent of the population is directly or indirectly dependent on fisheries.

Bangladesh is rich in fish resources with 260 freshwater and 475 marine fish species and about 60 species of prawn and shrimp. The hilsa fish (*Tenualosa ilisha*) is the largest single species fishery in Bangladesh contributing to about 11 per cent of total fish production and 1 per cent to national GDP. Hilsa is part of the culture and heritage of the country and is the national fish of Bangladesh. It provides employment for half a million professional fishers, with a further 2.5 million people engaged in part-time fishing and ancillary activities. More than 60 per cent of global hilsa production is from Bangladesh, followed by 20 per cent from India and 15 per cent from Myanmar.

Once abundant, hilsa production has gradually declined in Bangladesh since the 1970s, mainly due to overfishing and the degradation of habitat. To arrest this decline, the government of Bangladesh undertook a comprehensive programme for the protection and conservation of hilsa. It introduced a complete fishing ban during March and April in hilsa nursery grounds and for a further fifteen days during the peak spawning season. Poor fishermen were compensated in kind for lost earnings through incentives and support for alternative income-generating activities (AIGA). According to available statistics, during 2004–05 and 2007–08, a total of 6,906 metric tonnes of food grain were distributed to poor fishermen, and 1,58,781 Mt during 2008–09 and 2014–15. As a result of this incentive-based hilsa management programme, hilsa production has increased significantly.

However, to make the programme more effective and sustainable, some payment-scheme issues needed to be resolved through field-oriented applied research. Economic Incentives to Conserve Hilsa Fish (*T. ilisha*) in Bangladesh is a research project financed by the UK'S Darwin Initiative.[1] It was undertaken jointly by the International Institute for Environment and Development (IIED) in London, the Bangladesh

1. The Darwin Initiative is a UK government grants scheme that helps to protect biodiversity and the natural environment through locally based projects worldwide. See: www.gov.uk/government/groups/the-darwin-initiative

Centre for Advanced Studies (BCAS) and Bangladesh Agricultural University (BAU) in collaboration with the Bangladesh government's Department of Fisheries in 2013–2016 for enhancing the effectiveness and sustainability of the incentive-based hilsa fishery management programme. The project has successfully assessed the current ecological and socio-economic dynamics of the hilsa fishery as well as institutional capacity needs, opportunities and gaps and proposed a national Hilsa Conservation Foundation. The project has played an important role in informing the design of the incentive-based hilsa management programme and created a platform for dialogue among various hilsa stakeholders in Bangladesh and beyond.

I hope that the outcomes and recommendations of this synthesis report will be of much use in hilsa fishery management and improving the livelihoods of fishing communities. I would like to thank the Darwin Initiative for supporting the hilsa research project and IIED, BCAS and BAU for its successful implementation in Bangladesh.

Dr Syed Arif Azad
Director General, Department of Fisheries (DoF), Ministry of Fisheries and Livestock (MoFL), Dhaka, Bangladesh

PREFACE

Globally, fisheries support millions of impoverished coastal communities, who rely on them for both food and work. Some 43.5 million people – mostly in the global South – are directly employed in fisheries; a figure that rises to nearly 300 million if you also consider those who work in associated processing, marketing, distribution and supply industries.

And yet, despite their social and economic benefits, fisheries resources are being degraded and overexploited at an alarming rate. Overfishing, pollution, habitat degradation and climate change are all damaging these resources and undermining the benefits they provide to millions of impoverished people across the global South in particular.

Many countries have tried to address the problem through regulation – imposing rules and restrictions on when, where and how fishing can take place, for example by restricting the mesh size of fishing nets or by issuing controlled fishing permits. But in many cases these approaches have failed to change unsustainable practices among fisher and coastal communities. To a large extent, this is because regulation does not adequately compensate these communities for loss of earnings, or because it provides no alternative livelihood option. An underlying problem is that markets do not easily capture the non-monetary values of coastal and marine ecosystem services and so they are rarely considered in resource management decisions, which instead favour land clearance or other unsustainable options that can, in the short-term, produce goods to sell in the market place.

Incentive-based schemes – in which natural-resource users are compensated or rewarded to change their destructive and unsustainable fishing practices – are increasingly acknowledged as an alternative to failed regulatory mechanisms. This economic incentive-based approach is already relatively widely used on land, for example within forest and watershed ecosystems. But its application in fisheries – where resources (fish) are more mobile and harder to monitor, and where property rights are often ill-defined or insecure – remains embryonic. If well designed, however, such schemes could play a significant role in incentivising fisher or coastal communities to conserve, restore and sustainably manage their resources. A growing number of examples from across the world point to ways in which adding incentives to existing 'regulatory' schemes can make them more effective in protecting both environments and livelihoods

One of the rare examples of both mismanagement and restoration of fisheries using an economic incentive-based mechanism is Bangladesh's most important single-species fishery: hilsa. The hilsa fish, called '*Ilish*' in Bengali, is of national importance to Bangladesh. It's one of the country's main staple foods. But increased demand for the fish, which is popular throughout South Asia, has led to pressure on the fish species. Not only is the hilsa in trouble, but so are the 3 million fishermen, fisherwomen and fishery workers who directly or indirectly depend on the fish for their livelihood.

Bangladesh has recognised that something needs to be done. The government has already declared five areas as sanctuaries for the fish. In return for not fishing in these areas, affected fishing communities or households are rewarded with sacks of rice or provided with inputs for alternative income-generating activities to start up small businesses to replace the lost income. This is an example of how economic incentives can be used to conserve fish resources.

However, the scheme is not without its flaws. Knowledge gaps highlight the need for further research into the effects the sanctuaries are having on hilsa stocks, and also how the scheme is reaching and affecting those people who depend on the fish for a living, particularly the poorest and most marginalised fishing communities.

In April 2013, IIED launched a project that aims to fill this gap by redesigning the system that rewards people who help to protect it. Working in partnership with the Bangladesh Centre for Advanced Studies and Bangladesh Agricultural University and in collaboration with the Department of Fisheries of the government of Bangladesh, we have worked with affected communities and ecosystems to learn about what is working and what is not to find ways to improve it.

The IIED study found that in order to enhance the effectiveness of the incentive-based hilsa management scheme, strengthening institutional capacities, equitable benefit sharing for achieving much-needed local legitimacy, considering scientific evidence on the complex socio-ecological systems of the fishery, and ensuring sustainable financing through the proposed hilsa conservation trust fund are critical to the effective and sustainable implementation of the scheme.

I believe the lessons from this rare example are extremely valuable in informing the design of other similar schemes globally.

Dr Andrew Norton
Director, International Institute for Environment and Development.

SUMMARY

For many countries, fisheries play an important role in meeting global food demands, while providing employment and income. But coastal fisheries are declining due to overfishing, compromising their sustainability (Pauly 2006) and fisheries management in developing world countries is complicated by significant poverty levels. Measures which are implemented without efforts to mitigate costs to communities generally fail (Worm *et al.* 2009).

In response, fisheries managers are increasingly using economic incentive-based approaches to regulate resource extraction (Bladon *et al.* 2014; Mohammed and Wahab 2013). These provide incentives for resource users to comply with legislation, can strengthen governance and improve the well-being of beneficiaries (Clements and Milner-Gulland 2014).

One of the rare examples of both mismanagement and restoration of fisheries using an economic incentive-based mechanism is Bangladesh's most important single-species fishery: hilsa. Bangladesh is one of the world's leading fish-producing nations. Once a cheap fish and affordable even for the poor, hilsa catches declined gradually over 30 years. They reached a low point of only 0.19 million tonnes in 1991–1992, then stagnated until 2001–2002. This prompted the government of Bangladesh to declare hilsa sanctuaries in 2003 and seasonally ban the fishing of hilsa at important stages in its life cycle. To compensate for lost earnings during the closure, and to incentivise compliance with the new regulations, the government started providing affected fishing communities with rice and alternative income-generating activities. While this approach offers a major breakthrough, it needs careful design to ensure its effectiveness and efficiency.

In 2013, the International Institute for Environment and Development (IIED) launched a Darwin Initiative-funded project, in partnership with the Bangladesh Centre for Advanced Studies (BCAS) and Bangladesh Agricultural University (BAU) and in collaboration with the Bangladesh government's Department of Fisheries (DoF) to improve the effectiveness of incentive-based hilsa management. The objectives were to:

- Carry out **ecological assessments** to better understand the biological and ecological requirements of hilsa fish and provide baseline data for water-quality monitoring.
- Conduct **social baseline assessments** with fisher communities and others affected by fishing bans.
- Evaluate the **legal and institutional** capacity of government and communities needed to support hilsa management.
- Evaluate the **equitability of the benefit-distribution mechanism** (beneficiary selection process, how costs are distributed, beneficiary preferences, unintended impacts).
- Examine whether a **conservation trust fund** could ensure the long-term financial sustainability of the hilsa management project.

This paper is a synthesis of the results and provides recommendations for addressing deficiencies of the existing scheme. It assesses the current ecological and socio-economic dynamics of hilsa fishery management and should be of use to those involved in hilsa fishery management and in improving the livelihoods of fishing communities.

SUMMARY OF LESSONS LEARNT

Since 2005, Bangladesh's hilsa fishery economic incentive-based mechanism has achieved a number of successes. The number of fishers receiving food compensation has steadily increased. Positive changes include larger hilsa-dominating catches and increased income from the larger hilsa catch. But inadequacies in the design of the hilsa management scheme remain, limiting its legitimacy and efficiency.

Legal and institutional framework

Governance involves a diverse range of institutions including public, private and civil-sector agents. Considerable effort has been made to implement a legal and institutional framework to support the Bangladesh hilsa fishery. Despite these efforts, the Darwin Initiative-funded hilsa research project highlighted a number of capacity and resource issues that are compromising the efficacy of the existing legal and institutional setting, including:

- Regulatory compliance and a lack of capacity for carrying out enforcement operations are major barriers to the effective management of the hilsa fishery. To address these issues, the institutional framework of fisheries management is increasingly shifting towards a more decentralised structure, commonly known as co-management. Decentralisation of fisheries governance and management could prove a useful approach for addressing compliance and resource issues in Bangladesh. Key informants from the DoF have already recommended devolving magistracy powers (or at least powers for issuing fines) to fishery officers to address the magistracy shortage (Islam *et al.* 2016).
- Shortages in staff capacity have impacted the DoF's ability to carry out the requirements of their mandate, compromising the quality of the data used for hilsa management. Staff capacity and limited staff resources, are common factors limiting data availability in many of the world's small-scale fisheries. Participatory monitoring could prove a useful tool for addressing the capacity shortages in the Bangladesh DoF, particularly with regard to data collection capacity. While there may be concerns over the accuracy of data yielded by local data collectors, recent research shows that with rigorous training and planning of the sampling design, local data collectors can produce accurate quantitative data (Danielsen *et al.* 2005; Yoccoz *et al.* 2001).

Equitable benefit and cost sharing

Evidence from existing economic incentive-based schemes highlights the importance of designing equitable benefit-sharing mechanisms for achieving local, national and international legitimacy, and supporting management activities. In 2013–2014, the government of Bangladesh successfully supported just over half of all affected households. However, results from the various studies discussed in this report highlight a number of challenges that are compromising the equitability of the current compensation scheme. These include:

- While the strategy of targeting *jatka* (juvenile hilsa) fishers appears to achieve both ecological and 'pro-poor' objectives, it compromises the equitability of the compensation scheme namely within the sanctuaries where all types of fishers are impacted by the fishing ban. A more equitable approach would involve targeting the poorest and most vulnerable of all fishers. Efforts to reduce intentional inclusion/exclusion errors have made the process of identifying beneficiaries independent of local government and councils by employing local school teachers to compile the beneficiary list.

- While the food compensation scheme has successfully reached just over half of all affected households, increasing the number of beneficiaries of the compensation scheme is heavily dependent on mobilising additional funds. One suggested mechanism for increasing access to funds is to reduce the transaction and administration costs of the compensation scheme. While costs are already low in relation to other similar schemes, further reductions may be achieved by simplifying the beneficiary selection process thereby reducing staff salaries, and sourcing rice locally, consequently reducing distribution costs. However, more significant increases in available funds may potentially be achieved through the establishment of a hilsa conservation trust fund.
- Support for the hilsa management scheme is further endangered by the fact that households do not always receive their full allocation of rice compensation. To provide a consistent and complete allocation, measures are needed to ensure the costs of all actors in the allocation and distribution process – not only sub-district chairmen – are reimbursed, thereby reducing the need to withhold rice from the beneficiaries (Haldar and Ali 2014).
- Ideally, preferred and actual compensation packages should converge. However, sometimes preferences of the recipient communities for certain compensation packages may be financially and logistically challenging (if not impossible) to deliver. Therefore, inevitably, there will be some divergence between 'preferred' and 'actual' compensation packages provided. Efforts must be made to narrow this gap. One way of doing this could be by designing financially and logistically plausible 'predetermined' compensation packages and consult recipient communities and households before decisions are made. Moreover, the results from the beneficiary preferences study support the conclusion from earlier studies that beneficiary preferences are dynamic (change over time based on experience). In order to capture these changes, assessments of preferences must undergo periodic review to ensure alignment with the design of the compensation scheme (eg Mohammed *et al.* 2013).
- To ensure the compensation scheme is equitable means to also account for the unintended consequences of regulatory changes and benefit distribution. As a consequence of the fishing bans, many fishers are forced to borrow money, largely from informal money lenders. Issues with informal money lenders include high interest-rate loans, and a burden on fishers to continue repaying debts throughout the fishing ban 'forcing' them to fish illegally. To mitigate this, as argued by Mohammed *et al.* (2014), microcredit services and products should be introduced and tailored to meet the needs generated by a fishing ban. This must include a 'grace period' that protects fishers from repaying capital or interest when the fishery is closed, which would in turn boost compliance with the ban. Well-thought-out microcredit should gradually liberate hilsa fishers from a cyclical debt trap and prevent the interest rates they pay rising when the fishery is closed.

Ecology and biology of hilsa fishery

A recent study exploring spawning seasonality of hilsa in Bangladesh indicates that spawning may occur earlier and for longer than previously supposed. In response to this conclusion, the government of Bangladesh recently extended the spawning season fishing ban from 11 days to 15 days (three days before and 11 days after the full moon). While the new ban period does not fully account for the likely duration of spawning activity, fishers are not currently compensated for the loss of earnings during the spawning season ban given its short duration. An extension of the fishing ban to 22 or more days will require that fishers are adequately compensated for their loss of earnings and food during this period (Mohammed and Wahab 2013).

There remains some uncertainty regarding the level of inter-annual variability in the timing and duration of spawning given the limited duration of this study and the rapidly changing climate within Bangladesh. To improve the predictability of spawning timing and duration for fisheries management will require further research over a longer time period and at a greater number of sites.

While threats acting independently of one another may pose little danger to a species, threats acting synergistically can significantly increase rates of decline. For example, fishing pressure can magnify the effects of climate change on populations of aquatic invertebrates (Harley and Rogers-Bennett 2004). While the impact of aquatic pollution on hilsa is not fully understood, numerous studies have demonstrated reproductive impairment in fish exposed to high levels of pollutants (eg Wu *et al*. 2003; Scott and Sloman 2004). Coupled with the growing threat of increasing global temperatures due to climate change, aquatic pollution may impede the recovery of hilsa even in the absence of fishing pressure. While government policies prohibiting the dumping of untreated industrial waste into aquatic systems have been enacted, many industrial plants either lack effluent treatment plants (ETPs) or fail to run them due to high implementation/running costs (Khan *et al.* 2009). Efforts are needed to enact policies that enhance compliance.

Similarly, sandbar formation due to siltation and submerged islands represent potentially significant barriers to hilsa recovery by blocking key migration routes. Continued damming, upstream dredging and loop-cutting, and reductions in freshwater flow will only exacerbate these issues further. In the short term, dredging may be required to ensure migration is unobstructed by these physical barriers, but this does not negate the need for long-term strategies to mitigate the causative factors of siltation.

Development of targeted conservation actions for the preservation of hilsa habitat and food (ie plankton) is also going to require further studies examining the unique biophysical characteristics of the hilsa sanctuaries. This will require biophysical assessments of not only hilsa habitat, but non-hilsa habitat and across different seasons to improve understanding of the characteristics that underlay the temporal and spatial patterns in hilsa and plankton abundance.

Sustainable financing

Financial investment in the hilsa fishery should pay dividends economically and ecologically. But overcoming financial challenges requires increased and sustained financing that is free from economic and political shockwaves. One way is to establish a hilsa conservation trust fund (CTF) to provide long-term funding for the compensation scheme, ensure equitable benefit sharing, widen the ban period and protection zones, support critical ecological research, and help develop long-term alternative livelihood strategies. A hilsa CTF would require a diverse financing portfolio, rigorous monitoring and evaluation to demonstrate the fund's efficacy, and an institutional framework to support its establishment and governance.

In considering that hilsa management activities require a long-term, sustainable source of funds an endowment fund has been proposed as the most suitable source of fund generation. Furthermore, a diverse set of funding sources has been identified (see Box 3) to buffer the hilsa CTF against potential fluctuations or the loss of a single source of funding.

WHERE NEXT?

Two issues underpin effective hilsa management: robust reporting, monitoring and evaluation protocols for identifying and responding to knowledge gaps, and data on non-fishing-related stressors. Overcoming these should improve the evidence base for making management decisions, and demonstrate the legitimacy and effectiveness of the hilsa management scheme to donors and the international fisheries community.

Reporting, monitoring and evaluation

Effective natural resource management requires a well-designed and adaptable set of protocols for reporting, monitoring and evaluation that can detect and respond to dynamic changes, such as the impact of fishing bans on hilsa abundance. Evidence of positive conservation outcomes can enhance national support and compliance, and attract donors. But detecting conservation outcomes means identifying appropriate monitoring tools with sufficient power to detect change, along with systematic, statistically robust monitoring programmes.

Managing non-fishing-related threats

The Hilsa Fisheries Management Action Plan (HFMAP) was entirely focused on banning fishing activity in key areas at certain times. However, this project highlights a number of other direct and indirect threats to the hilsa fishery: illegal fishing activity and the lack of resources for enforcement, and siltation and pollution of critical hilsa habitat. More research is needed to better understand the likely impact of these threats.

Improving understanding of the impact of threats

What drives illegal behaviour? Understanding this is key. Enforcement policies must address compliance issues – as enforcement alone may only exacerbate poverty and promote negative perceptions of the regulatory scheme. While studies of compliance issues are complicated (rule breakers do not like to tell the truth), in recent years, tools have been developed to accurately estimate illegal harvest levels and understand

compliance issues. These could provide a rapid, low-cost assessment of non-compliance hotspots and drivers allowing government to carry out targeted enforcement patrols, and develop effective policies.

Cross-sector coordination and cooperation

Policy to address non-fishing-related threats will require coordination and cooperation across all sectors impacting hilsa management and habitat. This should identify any divergences or potential for conflicting policies. The following pointers (Roux *et al.* 2008) are particularly suited to the hilsa scheme given its scarcity of skilled people and as economic development, job creation and provision of basic services take precedence over conservation.

- Environmental policy integration and using the best available science to inform policy provides a platform for inter-sector dialogue and negotiation. Integrating science and policy often fails due to a weak institutional setting. Overcoming this issue requires reasoned negotiations. Discussions about what constitutes the best available science to inform policy can help to foster a research-driven environment.
- Enabling cooperation can incur costs. It requires a skilled, independent boundary-spanning agent to facilitate discussions and negotiations to find a common vision and goal. The agent would preferably come from a sector on the boundary of science and policy, with an understanding of the commonalities and differences between each.
- Goals developed during informal cross-sectoral discussions need to be integrated into formal policy and management processes. This is best done by a lead agency, not an individual. Establishing cross-sectoral cooperation and integrating policies, actors and funding should be viewed as long-term commitments to ensure the permanency of the scheme.

Transboundary approach to hilsa fisheries management

Migratory species are rarely distributed within political boundaries, thereby demanding transboundary cooperation for their conservation. Transboundary cooperation improves the effectiveness of conservation schemes by reducing the need for duplicated research effort, increasing effort to tackle wide-scale threats, and improving national support for the scheme (Erg *et al.* 2012). However, fostering transboundary cooperation is rarely straightforward, particularly where there are competing environmental objectives, and diverse legal and institutional governance structures (Erg *et al.* 2012), and so requires forums in which to facilitate dialogue between the various stakeholder groups.

ONE
INTRODUCTION

1.1 SUSTAINABLE FISHERIES

The last century has seen a rapid development in tools for increasing global food production, from aquaculture and agriculture to genetic modification. Despite these advancements, long-term food security, particularly in South Asia and sub-Saharan Africa, is being compromised by a rapidly increasing human population (Lele 2010), intensifying the need for mechanisms to sustainably manage food resources.

For many of the world's countries, fisheries play an important role in meeting global food demands, in addition to providing employment and income. In 2010, fish accounted for 16.7 per cent of the global population's animal protein intake (FAO 2014). In 2012, around 58.3 million people were engaged in capture fisheries and aquaculture, with 84 per cent located in Asia (FAO 2014). Over the last 50 years, global landings of fish have increased at an average rate of 3.2 per cent per year (FAO 2014). Despite this upwards trend in landings, coastal fisheries are declining due to overfishing, compromising the sustainability of this important resource (Pauly 2006).

In response to declining fish landings, fisheries managers have employed a variety of methods for regulating resource extraction, including fishing-gear modifications and bans of harmful fishing gear such as gillnets with small mesh sizes, temporary and permanent fishery closures, and fishing quotas. However, fisheries management in developing world countries is complicated by significant poverty levels within fishery-dependent communities. They are unable to bear the short-term economic costs commonly associated with fishing bans and gear restrictions (Mohammed 2012). Where management measures have been implemented without efforts to mitigate the costs to communities, these projects have generally failed due to a lack of support and hence an unwillingness to adhere with regulations (Worm *et al.* 2009).

In an effort to improve support, and thereby compliance, for regulatory approaches, fisheries managers are increasingly employing the use of economic incentive-based approaches[2], such as payments for ecosystem services (PES)-type schemes (Bladon *et al.* 2014; Mohammed and Wahab 2013). In addition to incentivising resource users to comply with fisheries legislation, economic incentive-based approaches can strengthen the institutional framework for fisheries governance and improve the well-being of the wider beneficiary community (Clements and Milner-Gulland 2014).

While economic incentive-based approaches are commonplace within terrestrial conservation, they have only recently been adopted as a regulatory tool within marine conservation (Mohammed and Wahab 2013). Despite their embryonic nature within marine systems, the following 'design essentials' have emerged from extensive reviews of existing examples of economic incentive-based approaches both within terrestrial and aquatic environments:

1) **Strong legal and institutional framework:** An appropriate legal instrument and a sound institutional framework are the backbone of a well-governed and efficient incentive-based scheme (Greiber 2009). In turn, a well-established legal and institutional framework can contribute to the development of

2. We use the term 'economic incentive-based approaches' to distinguish between incentive-based schemes, and payments for ecosystem services (PES) schemes that fulfil the criteria outlined in Wunder (2005).

trustworthy markets. There is no 'silver bullet' approach to the design of an appropriate institutional setting for incentive-based schemes, and so the institutional framework is typically customised to the existing circumstances of the country in question. This topic will be discussed further in Section 3.

2) **Equitable benefit-sharing mechanisms:** Natural resource stewardship often involves limiting the level of resource extraction. In an attempt to compensate resource users for the costs associated with resource stewardship, mechanisms have been created to share the benefits of stewardship. Benefit sharing in the context of conservation, and as defined by the Convention on Biological Diversity (CBD), is defined as the 'the fair and equitable sharing of the benefits arising out of the utilization of genetic resources' (CBD Secretariat 2011). Equitable benefit sharing is a critical component of resource-stewardship schemes as it provides local, national and international legitimacy, and supports management by incentivising stakeholders to adhere to regulations (Campese 2012; Mohammed 2011). Despite the identified need for equitable benefit sharing, many traditional mechanisms for facilitating benefit sharing – particularly within small-scale fisheries – have deteriorated due to command-and-control fisheries management with many small-scale fishers never receiving any of the benefits from fisheries management (FAO 2012). Equitable benefit sharing will be discussed further in Section 4.

3) **Enhanced understanding of biological and ecological knowledge:** Effective design of regulatory tools for natural resource management is underpinned by robust data on the biology and ecology of the species in question. This topic will be discussed further in Section 5.

4) **Mechanisms to ensure financial sustainability of the scheme:** Financial sustainability is reliant on consistent and continual financing mechanisms to maintain support for the scheme among resource users and ensure they do not return to unsustainable practices (Mohammed and Wahab 2013). There are multiple ways of ensuring financial sustainability of such schemes. In recent years, there has been growing use of conservation trust funds (CTFs), or environmental funds, for financing biodiversity conservation. This topic will be explored in further detail in Section 7.

5) **Clearly defined tenure:** 'Tenure' describes how users gain access to natural resources. Ill-defined tenure is a problem that plagues many of the world's fisheries, particularly in countries with a weak governance setting. Inadequate and insecure access to fisheries are often associated with poverty and hunger (FAO 2013) as well as unsustainable use of natural resources (Mohammed and Wahab 2013). Addressing these issues depends on the recognition of the customary rights of local resource users, and the facilitation of opportunities for co-management (Mohammed and Wahab 2013). This topic will not be explored in further detail as it is beyond the scope of this paper.

1.2 OBJECTIVES AND METHODS USED

One of the rare examples of both mismanagement and restoration of fisheries using an economic incentive-based mechanism is Bangladesh's most important single-species fishery: hilsa. In 2004, an economic incentive-based scheme was developed to support management of the hilsa (*Tenualosa ilisha*) fishery in Bangladesh following observed declines in annual landings. However, cases of illegal *jatka* fishing continue to grow (Islam *et al.* 2016).[3] Research carried out by the Bangladesh Centre for Advanced Studies (BCAS) and the Bangladesh Agricultural University (BAU) identified a number of inadequacies both with the hilsa fishery regulatory framework and the compensation scheme that were likely to be reducing public support and therefore compliance with legislation. In 2013, the International Institute for Environment and Development (IIED) launched a Darwin Initiative-funded project, in partnership with BCAS and BAU and in collaboration with the Bangladesh government's Department of Fisheries (DoF), which sought to address these inadequacies and improve the effectiveness of incentive-based hilsa management. The objectives of this project were to:

- Carry out **ecological assessments** to better understand the biological and ecological requirements of hilsa fish and provide baseline data for water-quality monitoring.
- Conduct **social baseline assessments** with fisher communities and others affected by fishing bans to characterise fisher dependence on the hilsa fishery, and preferences regarding compensation types and mechanisms.
- Evaluate the **legal and institutional** capacity of relevant government authorities and communities to ensure there are the necessary institutional structures to support hilsa management.
- Evaluate the **equitability of the benefit-distribution mechanism** with a focus on the beneficiary selection process; how costs of the scheme are distributed; beneficiary preferences; and the unintended impacts of the compensation scheme.
- Examine a **conservation trust fund** as a potential tool for ensuring the long-term financial sustainability of the hilsa management project.

This paper is a synthesis of the results from these studies and provides our recommendations for addressing deficiencies of the existing scheme. Data from the project were compiled from interviews and focus group discussions (FGDs) with key informants (fishers, officials from the DoF, fisheries' scientists) between 2012 and 2014; a large-scale questionnaire survey with approximately 900 households in 2014; two workshops, one on incentive-based hilsa conservation and management (March 2013), and the other on payments for hilsa conservation (May 2013); and standard ecological surveys

3. Juvenile hilsa fish are known locally as *jatka*.

exploring the spawning seasonality, habitat and feeding characteristics of hilsa (carried out between September 2013 and December 2014).

In Section 2, we provide an overview of the Bangladesh fisheries, the hilsa fishery and the Hilsa Fisheries Management Action Plan (HFMAP). In Section 3, we provide an overview of the legal and institutional framework supporting governance of the hilsa fishery. In Section 4, we present results on the equitability of benefit distribution in terms of the distribution of costs, beneficiary preferences and unintended consequences of hilsa management and benefit distribution. In Section 5, we address some of the major knowledge gaps relating to hilsa biology and ecology and the impacts this has on spatial management. In Section 6, we discuss the existing transboundary agreements on hilsa management between India, Bangladesh and Myanmar. In Section 7, we explore the potential for a conservation trust fund as a long-term sustainable financing mechanism to support hilsa conservation. Finally, in Section 8, we provide an overview of the lessons learnt from these various studies and the steps required to improve the effectiveness of hilsa conservation.

TWO
BANGLADESH FISHERIES

Bangladesh is one of the world's leading fish-producing nations. According to the latest available data, in 2011–2012, fish production amounted to 32.62 metric tonnes contributing 4.39 per cent to the country's national GDP, 2.46 per cent to foreign exchange earnings, and 60 per cent to all consumed animal protein (FRSS 2013). In addition to its economic importance, the fisheries sector is a significant source of employment with 11 per cent of the country's population directly or indirectly involved in this sector (FRSS 2013).

2.1 THE HILSA FISHERY IN BANGLADESH

The hilsa shad (*Tenualosa ilisha*)[4] is an economically important migratory fish native to the coastal waters of South and Southeast Asia. Hilsa spend much of their life in coastal waters but they migrate upstream to spawn in coastal rivers (Rahman and Naevdal 2000).

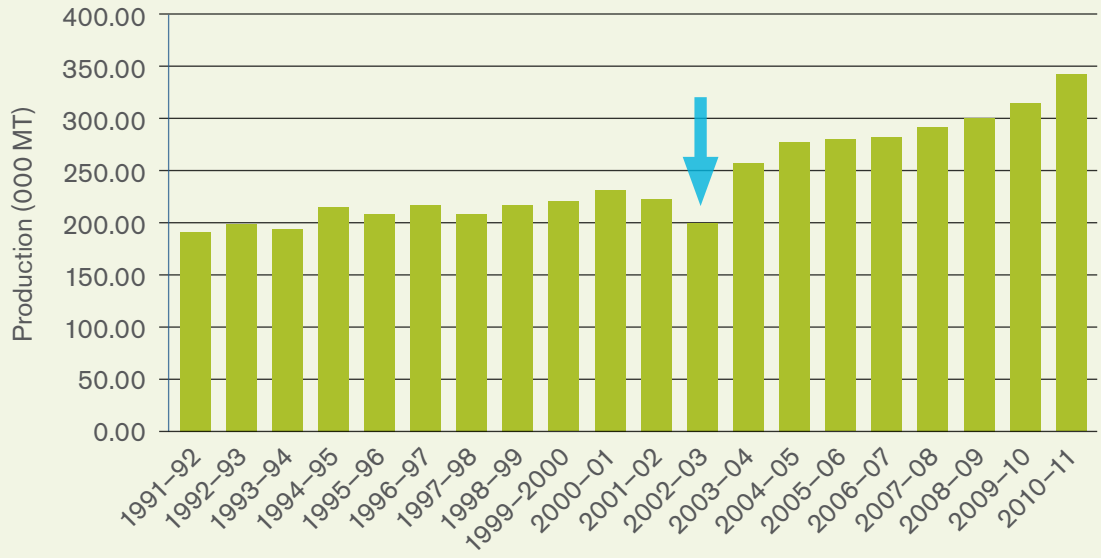
The hilsa fishery is the biggest single-species fishery in Bangladesh with landings contributing approximately 10 per cent to annual fish production (FRSS 2014), 1 per cent to the country's annual GDP (DoF 2014) and US$ 630 million in export revenue (Mome 2007). While broadly distributed from Vietnam to the Persian Gulf (Freyhof 2014), the majority of the global hilsa catch is taken by Bangladesh (50–60 per cent) with relatively smaller proportions taken by Myanmar (20–25 per cent), India (15–20 per cent) and other countries (5–10 per cent) (Rahman *et al.* 2012). In addition to the significant income generated from the hilsa fishery, there are an estimated half a million people directly dependant on the fishery as well as a further 2.5 million indirectly involved in supply-chain activities such as processing, transportation and marketing (Rahman *et al.* 2012).

In 1991, following a 20-year observed decline in reported hilsa landings, the Bangladesh government's Department of Fisheries (DoF) established a hilsa fishery monitoring and research programme (Mohammed and Wahab 2013). Research has focused on improving knowledge of hilsa biology and ecology, threats, and the measures necessary for long-term sustainable management of the fishery. Numerous studies have concluded that a burgeoning human population and a corresponding demand for fish protein has driven mass overfishing of *jatka* and adults in the gill net[5] fishery (Amin *et al.* 2008 and 2002; Rahman *et al.* 2013). Further research carried out by the Global Environment Facility (GEF) concluded that the hilsa catch could be increased by 45 per cent by imposing restrictions on *jatka* fishing at four major landing sites (Ali 2013 cited in Mohammed and Wahab 2013). So in 2003, following a further decline in the reported annual landings of hilsa (Figure 1), the Bangladesh government established the Hilsa Fisheries Management Action Plan (HFMAP).

4. While there are three separate species of Hilsa (*Hilsa kelee*, *H. toli* and *Tenualosa ilisha*), where we use the term 'hilsa' throughout this paper we are referring to *T. ilisha* as it the most numerous species making up to 99 per cent of the annual fish catch in Bangladesh.

5. A fishing net that is hung vertically in the water column and typically made of monofilament or multifilament nylon. The mesh sizes are designed to allow fishes to get only their head through the netting. The gills of the fish then become caught in the net when they try to escape (NOAA 2014).

FIGURE 1. TOTAL HILSA CATCH LEVEL IN BANGLADESH (1991–2011)



Source: Data obtained from DoF; analysed by authors.

2.2 THE HILSA FISHERIES MANAGEMENT ACTION PLAN

The HFMAP constitutes the first attempt by any country at hilsa conservation. Based on research carried out by the Bangladesh Fisheries Research Institute (BFRI), the action plan outlines key activities for the preservation of *jatka* (commonly referred to as the Jatka Conservation Project), the implementation strategy and associated timeframe, and responsibility of the key agencies. Key activities are as follows:

- Establishment of five sanctuaries (ie large areas designated as a refuge from fishing) in major fishing grounds thought to hold important nursery grounds,
- Establishment of four nationally important spawning grounds,
- Implementation of a nationwide 15-day fishing ban in October for the preservation of brood hilsa (only enforced in the recognised spawning grounds),
- Enforcement of the Protection and Conservation of Fish Act (1950),[6] and
- Offering compensation to fishers affected by the ban in the form of rice and/or support in developing alternative income-generating activities.

In 2005, four sites were declared hilsa sanctuaries under the Protection and Conservation of Fish Rules (1985) based on their recognition as important *jatka* nursery sites (Figure 2). A fifth sanctuary was declared in 2011. All forms of fishing are banned in the sanctuaries at certain times of the year for a period of two to three months to coincide with peak *jatka* abundance (Table 1). Furthermore, every year there is a nationwide ban on the catching, selling, transportation, marketing and possession of *jatka* between the 1st of November and 30th of June. In 2011, a shorter ban of 11 days from late September to October – recently extended to 15 days (see section 5.5.1 for further details) – was introduced at four locations (Chittagong, Patuakhali, Bhola and Cox's Bazar districts) to protect the hilsa brood stock and allow for uninterrupted spawning (Figure 2). Efforts to generate awareness and support for the fishing bans have been carried out using boat rallies in the major hilsa fishery rivers, mass media, distribution of leaflets and posters explaining the importance of *jatka* conservation and involvement of public representatives in management interventions.

6. The Protection and Conservation of Fish Act (1950) is the basic act regulating the hilsa fishery. See Section 3 for further details.

FIGURE 2. MAIN HILSA NURSERY GROUNDS AND THE 'NO-TAKE' ZONE IN BANGLADESH WATERS

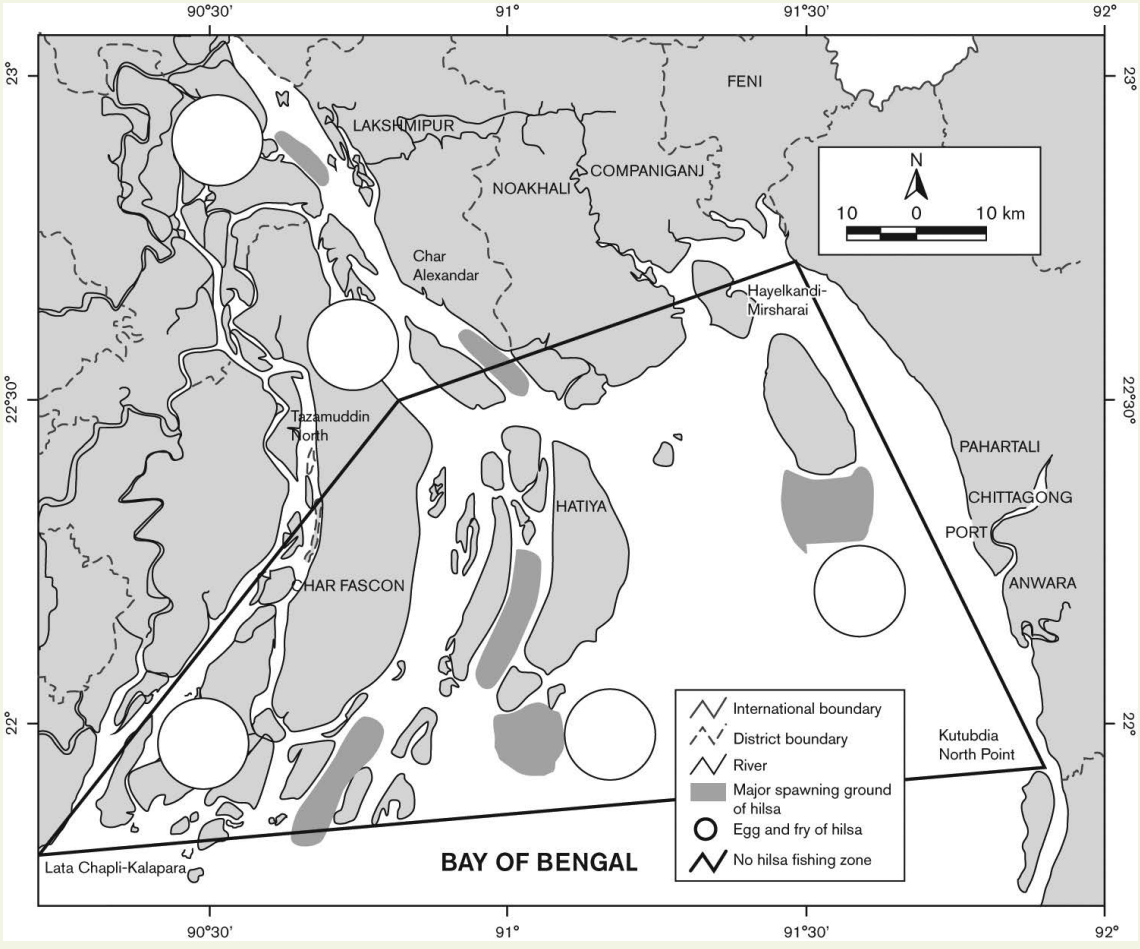


TABLE 1. HILSA SANCTUARY AREAS AND BAN PERIODS

HILSA SANCTUARY AREA	BOUNDARY	BAN DURATION
100km stretch of the lower Meghna River from Shatnol, Chandpur district, to Char Alexander, Laxmipur district	Shatnol Point (90° 37.12′E and 23° 28.19′N) Char Alexander Point (90° 49.30′E and 22° 40.92′N)	March to April
90km stretch of Shahbazpur channel, tributary of the Meghna River, Char Ilisha	Char Ilisha Mosque Point (90° 38.85′E and 22° 47.30′N) Char Pial Point (90° 44.81′E and 22° 5.10′N)	March to April
100km stretch of the Tetulia River from Bheduria, Bhola district to Char Rustam, Patuakhali district	Bheduria Ferryghat Mosque Point (90° 33.89′E and 22° 42.31′N) Mandolbazar (Char Rustaih) (90° 31.40′E and 21° 56.32′N)	March to April
Whole 40km stretch of the Andharmanik River in Kalapara *upazila*[7], Patuakhali district	Golbunia Point (90°19.20′E and 21°57.68′N) Confluence of Bay of Bengal and Andhermanik River (90° 3.91′E and 21° 49.43′N)	November to January
20km stretch of Lower Padilla River, between Naria-Bhedorganj *upazila*, Shariatpur District in the north and Matlab *upazila*, Chandpur District and Bhedorganj *upazila*, Shariatpur district in the south	Kachikata Point of Bhedorganj *upazila*, Shariatpur district in the northeast (90° 32.6′E and 23° 19.8′N) Bhonikara point of Naria *upazila*, Shariatpur district in the northwest (90° 28.8′E and 23°18.4′N) Beparipara Point of Matlab *upazila*, Chandpur district in the southeast (90° 37.7′E and 23° 15.9′N) Tarabunia Point of Bhedorganj *upazila*, Shariatpur district in the southwest (90° 35.1′E and 23°13.5′N)	March to April

Source: reproduced from Islam *et al.* (2016).

7. An *upazila* is a sub-district.

In addition to the management measures detailed in the HFMAP, pre-existing regulations on certain types of fishing gear and fishing vessels also serve to support hilsa conservation. In 1988, a ban was placed on the use of current nets – a plastic monofilament gill net with a mesh size of less than 4.5 cm – under the 1950 Protection and Conservation of Fish Act due to concerns about high levels of bycatch of juvenile fish. Furthermore in 2001, efforts were already underway to try and regulate and monitor the number of fishing vessels entering the hilsa fishery by introducing a one-off registration fee for newly commissioned hilsa fishing vessels, as well as an annual fishing licence.

2.3 INCENTIVE-BASED HILSA FISHERIES MANAGEMENT SCHEME

As part of the HFMAP, the government implemented a compensation scheme to alleviate the economic burden on fishers affected by the new hilsa regulations. Two types of compensation are offered: rice, and support for establishing alternative income-generating activities (AIGA). Food grain compensation is issued through the government's Vulnerable Group Feeding Programme (VGF). The HFMAP recommends that *jatka* fisher households directly affected by the establishment of the sanctuaries are to be compensated with 30kg of rice – recently increased to 40kg – per month for a period of at least four months (Haldar and Ali 2014).

The AIGA scheme aims to make hilsa fishers less vulnerable by providing training and materials that allow them to diversify their income sources. Once fishers have received support from the AIGA programme, they are typically not entitled to compensation through the VGF programme. At present, the scheme offers assistance in establishing 11 different types of AIGA including livestock rearing, sewing, agriculture and net mending (Haldar and Ali 2014). However, allocation of AIGA has been declining and in 2014 only 0.5 per cent of households receiving compensation received AIGA support.

THREE
LEGAL AND INSTITUTIONAL FRAMEWORK OF THE HILSA FISHERY

Effective design of the institutional framework for an incentive-based scheme should be guided by local circumstances, particularly the political setting, but will demand coordination between public and private institutions, a common vision, clarification of the roles of each institution, formalisation of communication channels, and identification of institutional complementarities (Greiber 2009). Incentive-based scheme legislation should be developed through practical experience and informed by local projects, to provide enhanced legal certainty and an enabling framework (Greiber 2009). A thorough understanding of the existing legal and institutional setting can help identify the potential for conflicts with existing legislation and make policy recommendations compatible with existing legal frameworks and institutional capacities.

In this chapter, we discuss the results from a study carried out by Islam *et al.* (2016) in which the authors describe the institutional and legal framework underlying the management of the hilsa fishery in Bangladesh, and make recommendations on how the framework might be improved. Data was collated from a review of legal, institutional and policy documents; published literature on the hilsa fishery; and key informant interviews and focus group discussions that were carried out between January and April 2014 (see Islam *et al.* 2016 for further details).

3.1 INSTITUTIONAL FRAMEWORK FOR FISHERIES MANAGEMENT

Fisheries jurisdiction falls under the Ministry of Livestock and Fisheries (MoFL) Department of Fisheries (DoF) which has responsibility for:

- Preparation of schemes and the coordination of national policy in respect of fisheries,
- The prevention of fish disease,
- The conservation, management and development of fisheries resources, and
- The management of fish farms and training and collecting information

The DoF is supported by the BFRI which is responsible for fisheries research and co-ordination, and the Bangladesh Fisheries Development Corporation (BFDC) that handles development of the fisheries industry. The mandate of the DoF is as follows:

- Dissemination of improved aquaculture technologies through training, demonstration and advisory services to stakeholders,
- To enhance fisheries resources through conservation and management measures,
- To assist the administrative ministry to formulate policies, acts, rules and ordinances,[8]
- To enforce quality-control measures and issue health certificates for exportable fish products,

8. 'Acts' are law passed by government. 'Ordinances' are laws passed by lower-level jurisdictions. 'Rules' define the guidelines that must be followed for the successful implementation of an act (Islam *et al.* 2016).

- To carry out fisheries resources monitoring and evaluation, including stock assessments,
- To facilitate arrangement for institutional credit for fish and shrimp farmers, fishers, fish traders and entrepreneurs,
- To facilitate alternative income-generating activities (AIGA) for the rural poor and unemployed,
- To ensure food security by formulating and implementing development grants focused on the sustainable utilisation of fishery resources, and
- Dissemination of improved aquaculture technologies through the e-extension service.[9]

The DoF currently has around 1,500 staff at the division, district and *upazila* levels of the country's administrative hierarchy (Box 1). The DoF also has a number of research and monitoring facilities: fish inspection and quality-control stations, marine fisheries stations, fisheries training academies, and hatcheries. Despite having representatives at each administrative level and the extensive facilities, the DoF struggles to meet the requirements of the mandate due to a lack of staff and physical resources which has impeded its ability to carry out biological research and coordinate between research bodies. Furthermore, the limited resources within the DoF are under increasing pressure from an increasing demand on fisheries resources, complex development needs and a flourishing private sector (Islam *et al.* 2016).

BOX 1. ORGANISATION OF BANGLADESH'S ADMINISTRATIVE HIERARCHY

DIVISIONS: the highest administrative tier, headed by the Divisional Commissioner, commonly known as the commissioner. The DoF representative is referred to as the Deputy Director (DD).

DISTRICTS: headed by a Deputy Commissioner (DC). The DoF representative is referred to as the District Fisheries Officer (DFO).

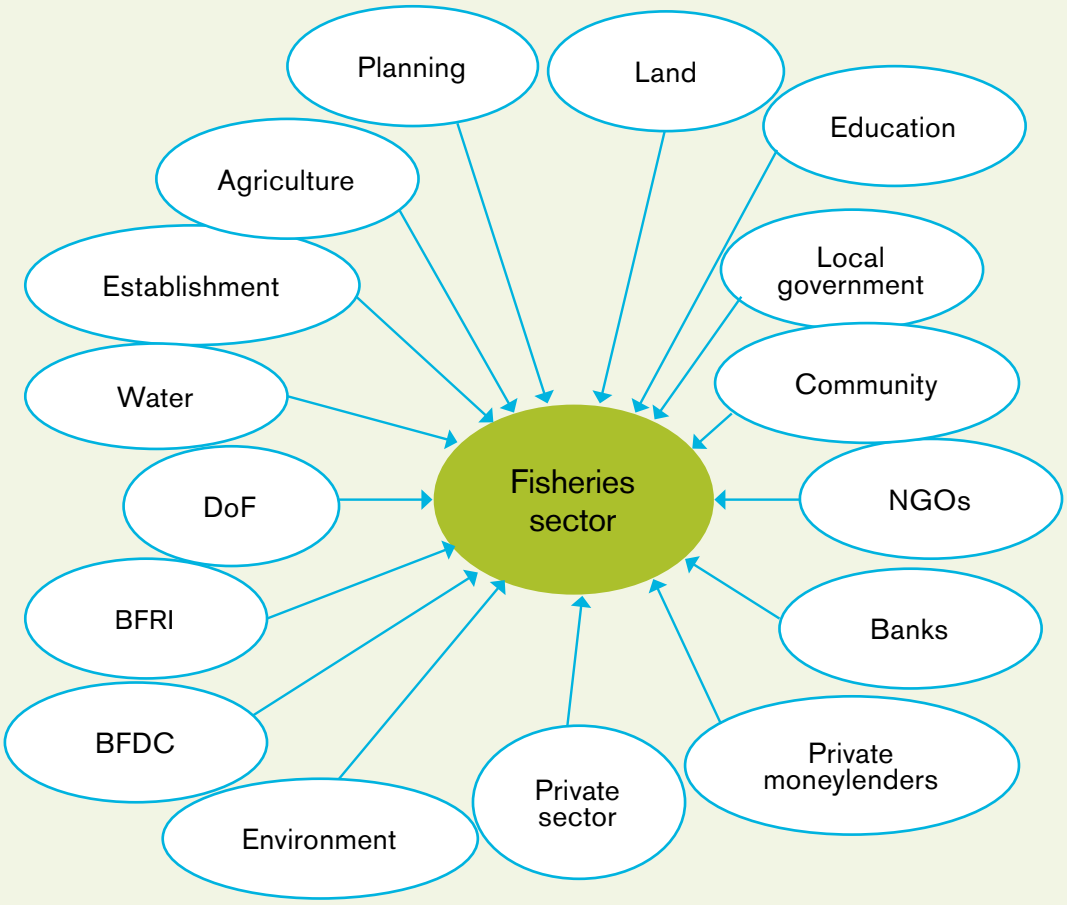
SUB-DISTRICTS or *upazilas*: headed by the Upazila Nirhabi Officer (UNO). The DoF representative is known as the Upazila Fisheries Officer (UFO), also known as the Thana Fisheries Officer.

UNION: the lowest administrative tier which is headed by the Union Parishad (council) Chairman (UPC).

While the DoF is the key institution involved in the governance of the hilsa fishery, a number of other formal and informal institutions – as well as public, private and civil-society sector agents – are involved, thereby complicating the process of policy making and regulatory control (see Figure 3).

9. See: www.dae.gov.bd

FIGURE 3. INSTITUTIONAL LINKS IN THE FISHERIES SECTOR



3.2 LEGAL AND POLICY FRAMEWORK

The HFMAP details a number of policies for the preservation of the hilsa stock. These policies include measures to restrict the use of particular fishing gear (i.e. current nets), seasonal fishing closures and regulations for fishing vessels. There are two acts, two ordinances and one rule that provide the legal framework to support these policies (Table 2). Additionally, there are a number of pre-existing policies that further support the hilsa fishery by addressing issues relating to the over-exploitation of natural resources, the preservation of biodiversity from an environmental and economic perspective, fishing rights and poverty alleviation (Table 3). Overall, there is little conflict between the policies developed both for the hilsa fishery and fisheries in general. While there has been a long-standing conflict in policies regulating the use of the current net in Bangladesh, this was recently resolved in a court case which has now banned both its use and manufacture (Azad 2016).

TABLE 2. A SUMMARY OF THE LEGAL FRAMEWORK SUPPORTING THE MANAGEMENT OF HILSA FISHERY

ACT, ORDINANCE OR RULE	RULE/REGULATION
Protection and Conservation of Fish Rules (1958)	Any fish caught in the sanctuaries or spawning grounds during the ban periods may be seized or forfeited (under the 2005 and 2011 amendments).
	An 11-day ban (recently changed to 15 days) on the harvesting of brood hilsa in the four major spawning grounds (under the 2011 and 2015 amendments).
Protection and Conservation of Fish Act (1950)	Ban on the manufacturing, fabricating, importing, marketing, storing, carrying, transporting, owning or possessing of a **current** net (under the 2002 amendment).
	Ban on fishing *jatka* across Bangladesh between November and June (under the 2013 amendment).
Territorial Waters and Maritime Zones Act (1974)	Demarcation of the hilsa sanctuaries.
Marine Fisheries Ordinance (1983)	Management, conservation and development of marine fisheries in water bodies deeper than 40m.
	Mechanised boats require a licence (under Amendment 92).
	Non-mechanised boats require a licence.
Mobile Court Ordinance (2007)	Provides a magistrate with the power to operate a mobile court to deal with offences 'on the spot'.

TABLE 3. PRE-EXISTING FISHERY POLICIES RELEVANT TO HILSA FISHERY

POLICY	PURPOSE
New Fisheries Management Policy (1986)	Addresses the over-exploitation of resources and inequality of fishing rights.
National Fisheries Policy (1998)	Increase fisheries production, alleviate poverty and improve the socio-economic conditions of fishers by creating self-employment opportunities; fulfil the demand for animal protein; achieve economic growth through earning foreign currency by exporting fish and fisheries products; achieve environmental stability and conservation of biodiversity; and provide recreational facilities.
Environment Policy (1992)	Emphasises the conservation and development of fisheries and the evaluation of any projects likely to impact on these resources.
Mobile Court Ordinance (2007)	A magistrate can operate a mobile court to deal with offences 'on the spot'.

3.3 ENFORCEMENT OF FISHERY REGULATIONS

Each year, the navy, coast guard, police, the rapid action battalion (RAB), the air force and the border guard carry out thousands of regulation enforcement operations. Any person found to contravene the fishery regulations is punished with a fine, prison sentence or both (Islam *et al.* 2016). Despite these efforts, since 2011 the number of cases of illegal *jatka* fishing has increased. Focus group discussions in the Chandpur district revealed that 5–8 per cent of fishers disregard the fishing ban, particularly at night when enforcement teams are less vigilant (Islam *et al.* 2016). A few interviewees also indicated that fishers sometimes manage to bribe local law enforcement in order to fish illegally.

Under the Mobile Court Ordinance (2007), a magistrate can sentence offenders on the spot. Theoretically, in order to operate, a mobile court requires a team of six to eight people from various government departments. However, poor availability of the mobile court members – notably magistrates and police officers – particularly during the night, means that many offences go unpunished and officials are discouraged from carrying out night-time operations.

Capacity to carry out enforcement activities is also impacted by a lack of funds to supply key resources such as boats and staff food. Regulatory enforcement teams currently rely on hired motorboats to carry out enforcement operations. However, boats are not always available and often are not as powerful as some

fisher boats. Interviewees also commented on the lack of adequate funds for running the mobile courts, noting that available funds typically only cover 50 per cent of the overall costs (Islam *et al.* 2016).

3.4 ISSUES TO CONSIDER

Governance involves a diverse range of institutions including public, private and civil-sector agents. Considerable effort has been made to implement a legal and institutional framework to support the Bangladesh hilsa fishery. Despite these efforts, the research by Islam *et al.* (2016) highlighted a number of capacity and resource issues that are compromising the efficacy of the existing legal and institutional setting.

3.4.1 Fisheries co-management: an opportunity to address compliance and capacity issues?

Regulatory compliance and a lack of capacity for carrying out enforcement operations are major barriers to the effective management of the hilsa fishery. In part, this may be attributed to the largely centralised nature of hilsa fishery governance within Bangladesh. Command-and-control fisheries management is often characterised by low levels of regulatory compliance (Kooiman and Jentoft 2009) and limited capacity for carrying out enforcement operations (Carbonetti *et al.* 2014).

To address these issues, the institutional framework of fisheries management is increasingly shifting towards a more decentralised structure, commonly known as co-management (ie the interaction of government and resource users in resource management). Additional to increased compliance and capacity, co-management offers a number of other advantages over a command-and-control approach, including:

- Reduction in the cost of administration and regulatory enforcement,
- Greater trust between government and resource users,
- Reduced conflict between resource users,
- Increased compliance with regulations, and
- Raising local and national consciousness of local environmental issues (Constantino *et al.* 2012; Nielsen 2003; Pomeroy and Rivera-Guieb 2006).

Decentralisation of fisheries governance and management could prove a useful approach for addressing compliance and resource issues in Bangladesh. Key informants from the DoF have already recommended devolving magistracy powers (or at least powers for issuing fines) to fishery officers to address the magistracy shortage (Islam *et al.* 2016).

While the advantages of fisheries co-management are widely acknowledged, co-management cannot be seen as a panacea for addressing issues within centralised governance (Berkes 2009; Pomeroy and Rivera-Guieb 2006). In terms of poverty reduction and empowerment of marginalised communities, evidence for co-management success is inconclusive. Additionally, it may create the conditions for localised elite capture of benefits (see Section 4 for further information), and strengthened state control (Berkes 2009; Larson and Ribot 2004). Given the huge investment of resources

required to establish co-management schemes, decentralising governance of the hilsa fishery would require an evaluation of the suitability of such a scheme for this particular fishery following the conditions and principles outlined in Pomeroy *et al.* (2001) while drawing upon the wealth of experience from similar fisheries co-management schemes within Bangladesh (see Thompson *et al.* 2003 for further details). Furthermore, given that devolved property rights form a key requirement of effective co-management (Pomeroy 2001), studies are needed to establish the distribution of property rights across the country.

3.4.2 Participatory monitoring: increasing capacity for research?

Shortages in staff capacity have impacted the DoF's ability to carry out the requirements of their mandate, compromising the quality of the data used for hilsa management. Staff capacity, in addition to limited staff resources, are common factors limiting data availability in many of the world's small-scale fisheries. In Bangladesh, it is estimated that the actual total annual fishery landings may be 157 per cent greater than the FAO-reported values due to limited capacity for monitoring commercial catches, discarded bycatch and subsistence catches (Ullah *et al.* 2014). Participatory monitoring[10] (ie the recording and analysis of information by local people) now plays a major role in addressing staff capacity shortages within the world's fisheries, particularly in countries where financial and human resources are limited (Danielsen *et al.* 2000). Participatory methods have been used to generate data on a diversity of subjects from the location of spawning aggregations to aid marine protected area (MPA) design (Hamilton *et al.* 2012) to bycatch patterns of marine mammals and turtles (Moore *et al.* 2010) and trends in abundance over time (Lozano-Montes *et al.* 2008).

Participatory monitoring schemes vary considerably in their dependence on local data collectors and professional scientists from schemes that are externally driven and use professional or local data collectors, to schemes that are entirely driven and executed by local people (Danielsen *et al.* 2008). The advantages of participatory methods are wide ranging and well documented. Engaging local people in resource-monitoring activities can facilitate co-management programmes and empower local communities, thereby enhancing the efficacy of resource management (Trimble and Berkes 2013). By employing local community members as resource monitors, rather than professional scientists, staff costs are reduced making participatory monitoring a financially attractive solution to addressing human resource deficiencies (Holck 2008). Furthermore, data collection by local resource users often reveals important information about local biodiversity that would be difficult to detect using standard ecological methods (Danielsen *et al.* 2005).

10. Also commonly referred to as 'community-based monitoring' and 'locally-based monitoring'.

Participatory monitoring could prove a useful tool for addressing the capacity shortages in the Bangladesh DoF, particularly with regard to data collection capacity. While there may be concerns over the accuracy of data yielded by local data collectors, recent research shows that with rigorous training and planning of the sampling design, local data collectors can produce accurate quantitative data (Danielsen *et al.* 2005; Yoccoz *et al.* 2001). Ticheler *et al.* (1998) have reported great success with the use of local fishers as data collectors in the Zambian Bangweulu Swamp fishery. Twelve literate fishers were employed by the Zambian government's Department of Fisheries to collect and record biological information on the species composition of catch; size of each individual fish; and fishing-gear type and dimensions with which it was caught. These data were then used to carry out a stock assessment of the swamp fishery. Employing local data collectors versus DoF staff reduced staff costs by 60 per cent yet generated data that was comparable to data collected by the DoF.

While participatory monitoring may alleviate some of the staff shortages within the DoF, the benefits may be limited to data collection rather than for more complex tasks involving data analysis and evaluation, highlighting the need for additional funding to address these gaps (see Section 7 for further details on sustainable financing).

FOUR
EQUITABLE BENEFIT-SHARING MECHANISMS

4.1 BENEFITS AND COSTS

Ensuring that the benefits of resource-stewardship schemes are shared equitably is crucial for achieving local, national and international legitimacy, and incentivising stakeholders to adhere to regulations (Campese 2012; Mohammed 2011). Since the inception of the CBD there has been a vast area of research on the theory and practice of designing equitable benefit-sharing mechanisms, the majority of which has been stimulated by the UN REDD+ programme.[11] Before we outline the design criteria for an equitable benefit-sharing mechanism, we first define what we mean by 'equitable' and 'benefit'.

The concept of what is deemed 'equitable' varies from study to study but may encompass one or more of the following principles:

- **Equality/egalitarian-based:** benefits should be equally shared among all beneficiaries,
- **Input/merit-based:** levels of benefits are based on contributions,
- **Needs-based or pro-poor:** benefits are based on beneficiaries' basic needs and seek to improve the well-being of poor, marginalised and/or vulnerable individuals, and
- **Rights/libertarian-based:** benefits are ascribed based on stakeholder rights.

The need to define and account for equitability is a crucial step in mechanism design given the inherent gender- and income-differentiated impacts of stewardship schemes. For example, fishing bans also impact on women working as fishers or throughout the supply chain, but benefits are often distributed to the male head of the household (Mohammed 2011). Similarly, poor design may make benefits vulnerable to 'elite capture' (ie where benefits for the wider population are captured by a few usually politically and/or economically powerful groups (Dutta 2009). Mohammed (2011) argues that where communities are more equal, benefit-sharing mechanisms should be founded on equality and merit-based principles. For communities characterised by social inequity, benefit sharing should be targeted towards poor, vulnerable and marginalised individuals (ie pro-poor).

Similarly, the types of 'benefits' vary considerably from study to study. Benefits may be direct or indirect, and monetary or non-monetary. Luttrell *et al.* (2013) distinguishes between three main types of benefit:

- Benefits from implementation of a management scheme (eg direct economic incentives, PES, carbon credits),
- Benefits from changes in the level of resource extraction (eg increased abundance/biomass of the target resource(s), improved provision of ecosystem services), and
- Indirect benefits (eg improved governance and infrastructure, livelihood restoration and enhancement, technological advancement).

To understand the equitability and economic efficiency of a benefit-sharing mechanism requires that we account for the benefits and costs of resource stewardship, and how they are distributed. According to Luttrell

11. REDD+ is the United Nations programme for reducing emissions from deforestation and forest degradation (REDD+) in developing countries. REDD+ provides guidelines on how to report on forest resources and forest-management strategies in terms of reducing emissions and enhancing greenhouse gas removal.

et al. (2013), costs either come in the form of financial expenditure or 'opportunity costs' (ie opportunities foregone due to the implementation of the stewardship scheme). Types of financial expenditure commonly associated with resource-stewardship schemes can be categorised into 'transaction' and 'administration' costs. Transaction costs are the costs associated with organising and participating in a market or implementing a government policy (eg purchasing land, compensation). Administration costs are the realised costs of managing an organisation (eg salaries, financial management). Costs vary with regards to who they impact most (Campese 2012) and are often differentiated by gender, class, age, ethnicity, religion, culture or race. For example, restrictions on fuelwood access will likely impact on women's workloads more than men's (Kanagawa and Nakata 2007). Similarly, the structural design of benefit distribution in PES programmes tends to be skewed towards the 'elite' (Pascual *et al.* 2010).

As costs can reduce the economic benefits of a stewardship scheme, and therefore willingness to comply with regulations, designing efficient schemes requires a thorough understanding of the factors governing costs and mechanisms for reducing them. Transaction and administration costs can account for up to 25 per cent of the total operational cost (eg Miranda *et al.* 2003).[12] Typical transaction and administration costs include staff salaries, materials and transportation. Some of the most common issues underlying high transaction costs are complexity of project administration and the benefit-distribution process, and conflicts between stakeholder groups, particularly where tenure is not defined (Pham *et al.* 2009; Wunder and Albán 2008; Wunder 2007).

4.2 DESIGN CONSIDERATIONS

Based on the lessons learnt from existing schemes, the following have emerged as important steps in designing an equitable benefit-sharing mechanism. Firstly, beneficiaries must be clearly defined and identified. After this, a consultation should be carried out with stakeholders to elicit information on preferences using a variety of participatory rural appraisal (PRA) tools, including stakeholder analysis (a method used to identify everyone with a concern or interest who needs to be involved in project planning) and the choice experiment method (a common technique used to identify respondents' preferences in terms of hypothetical changes to the attributes of a scheme). Consultation with stakeholders can be used to determine what is deemed 'equitable'; the preferred payment/benefit type ('in cash' or 'in kind' eg training, materials or food) and distribution mechanism; whether payments are made to individuals, households or communities; and the economic and social impacts of benefit distribution (Campese 2012; FFI 2014; Mohammed 2011).

Despite efforts to consult with stakeholders, the inevitable complexity of many stewardship schemes – particularly those involving large numbers of participants – means that there

12. However, it is important to note that benefit distribution in PES schemes is conditional on proven provision of natural resources and therefore has the additional cost of monitoring. For compensation schemes such as the one described in this paper, there is no cost from monitoring activities as proven provision of natural resources is not a condition of the scheme.

is often considerable uncertainty regarding appropriate types and levels of benefits. In-cash and in-kind payments may be distributed differently within households depending on gender and age (Mohammed 2011). Similarly, cash payments can help to alleviate poverty in vulnerable communities by helping beneficiaries purchase basic necessities (such as food, clothing or medicines), while in more rural communities where cash is rarely used for purchasing goods, in-kind payments may be more useful to the beneficiary (Mohammed 2011).

As benefit-sharing mechanisms may be a new concept to many stakeholder groups, many benefits and costs are likely to be unaccounted for, with many never being realised until the scheme has been implemented. Additionally, many benefits and costs, particularly non-monetary and opportunity costs, may be difficult to value. Given the inevitability of changes both in individual/community preferences and potentially unaccounted for economic and social impacts, regular consultations are needed to detect these changes and incorporate them into the scheme framework. Many similar schemes have performed poorly where management practitioners have failed to account for the needs, constraints and practices of local communities (Johnson *et al.* 2001).

4.3 OBJECTIVES AND METHODS

The current compensation scheme offers two types of in-kind support in the form of rice and AIGA (see Section 2.3). Initial selection of these compensation types was not based on recipient preferences, but on the availability of resources: both the VGF and AIGA compensation schemes had been established prior to the hilsa management scheme. BCAS observed that some women were selling the sewing machines issued through the AIGA scheme because they did not know how to use them thus identifying a need to better understand the preferences of beneficiaries.

In this paper, we assess the cost effectiveness and efficiency of the hilsa incentive-based scheme. This is done to recommend ways to minimise costs and maximise benefits to recipient communities.

Data on the beneficiary-selection process and unintended consequences of benefit distribution were collected by the Bangladesh Centre for Advanced Studies (BCAS) using:

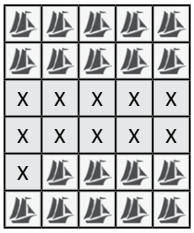
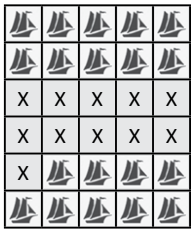
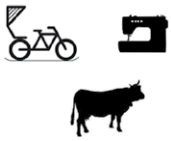
- Secondary data, interviews and focus group discussions with the fisheries and other relevant departments,
- Key informant interviews with individuals with specialist knowledge in this subject area, and
- Online resources and literature reviews.

The results of this research were initially published in Haldar and Ali (2014) and Mohammed *et al.* (2014).

Data on the transaction and administration costs of the food compensation scheme were collected from focus group discussions with *upazila* chairmen, UFOs, DFOs and the Department of Fisheries officials and have been published in Haldar and Ali (2014).

Data on preferences were collected by enumerators of BCAS from experiments with key informants using the choice experiment method (see Figure 4). The experiment was carried out with 900 households within and outside of the *jatka* sanctuaries, and with beneficiaries and non-beneficiaries of the compensation scheme,

FIGURE 4. EXAMPLE OF A CHOICE CARD

Attributes	Alternative 1	Alternative 2	Alternative 3
Ban on *jatka* fishing	J F M A M J J A S O N D X X X X X X	J F M A M J J A S O N D X X X X X X	
	8 months	8 months	
Ban on hilsa brood fishing			
	11 days (5 days before and after the full moon)	11 days (2 days before and after the full moon)	
In-kind compensation			
	30kg of rice per household x 4 months	Alternative income-generating activity (only one of the 3 options)	
Cash compensation			
	6,000 Taka	24,000 Taka	
Payment frequency			I would not choose any
	Per month	One off	
Tick your most preferred alternative (✓)	☐	☐	☐

the results of which have been extracted from Mohammed and Brouwer (unpublished). During the experiment, each interviewee was presented with six choice cards (Figure 4) each of which had varying permutations of five attributes (ie length of the fishing ban on hilsa and *jatka*, the types of compensation they receive, frequency of cash payments). Each choice card offered three alternative scenarios, two of which were permutations of the five attributes and the other which was an 'opt out' choice.

4.4 BENEFICIARY SELECTION, COMPENSATION ALLOCATION AND DISTRIBUTION

In 2013–2014, the Bangladesh government allocated approximately BDT 1,238.73 million (approximately US$ 15.771 million) for compensation which, given the costs of the scheme (see Section 4.5 on transaction and administration costs), meant only 226,852 of the 450,000 households affected by hilsa regulations received rice compensation with a further 905 households offered AIGA support. While only half of all affected households currently receive rice compensation, this figure has been steadily increasing year-on-year from 145,335 households in 2007–2008 (Table 4). AIGA support has been less widespread with 21,690 households receiving some form of support between 2009 and 2014 (Table 5). Furthermore, participation in the scheme has fallen from its peak of 7,785 in 2011–2012, to only 905 in 2013–2014 with 'a mismatch in preferences and support provided' most commonly cited as the reason for this decline (Islam *et al.* 2016; Mohammed and Wahab 2013).

Given the financial constraints on compensation distribution, benefits are reported to be targeted at the poorest and most vulnerable *jatka* fisher households living within the sanctuaries and therefore affected by the seasonal fishing ban. While Bladon (2016) found some evidence, albeit weak, to support the assertion that the scheme is 'pro-poor', there was no evidence to support the claim of preferential targeting of *jatka* fishers. Interviews and focus group discussions have revealed a number of weaknesses in the beneficiary selection, allocation and distribution process that have driven the mistargeting of benefits (Haldar and Ali 2014).

Anecdotal evidences suggest that some *upazila* chairmen and members reported including additional people from their own constituency on their beneficiary lists, or adding the same person twice, to increase the rice allocation to their constituency and gain political support. Conversely, genuine beneficiaries may be excluded for political reasons. Regardless whether such claims are based on perceived or actual misuse of power and misappropriation of resources, they pose a threat to the effectiveness of the scheme by reducing legitimacy of the scheme.

Further to this politicisation, the issue of accurately targeting *jatka* fishers has largely been attributed to a problem of identification (Bladon 2016). There are no defining characteristics in terms of fishing gear that distinguish *jatka* fishers from hilsa fishers. Furthermore, genuine *jatka* fishers may not be willing to disclose that they target *jatka* for fear of retribution, and non-*jatka* fishers may claim to catch *jatka* in an attempt to receive benefits (Bladon 2016).

TABLE 4. SUMMARY DATA ON FOOD COMPENSATION

FINANCIAL YEAR	NUMBER OF HOUSEHOLDS RECEIVING FOOD	AMOUNT PER HOUSEHOLD PER MONTH (KG)	DURATION (MONTHS)
2004–2005	33,300	10	3
2006–2007	103,000	15	1
2007–2008	145,335	10	3
2008–2009	143,252	10	3
2009–2010	164,740	30	4
2010–2011	186,264	20	4
2011–2012	186,264	30	4
2012–2013	206,229	30	4
2013–2014	226,852	40	4

Source: reproduced from Haldar and Ali (2014).

TABLE 5. SUMMARY DATA ON AIGA SUPPORT

FINANCIAL YEAR	NUMBER OF HOUSEHOLDS SUPPORTED	DISTRICTS COVERED	*UPAZILAS* COVERED	NUMBER OF HOUSEHOLDS SUPPORTED PER *UPAZILA*
2009–2010	4,388	Chandpur, Bhola Laxmipur, Patuakhali	20	219
2010–2011	6,869	As above	21	327
2011–2012	7,785	As above	21	371
2012–2013	1,743	As above	16	109
2013–2014	905	As above	22	41
Total number of households	21,690			

Source: reproduced from Haldar and Ali (2014).

The issue of mistargeting beneficiaries (exclusion error) is further exacerbated by the complexity of the selection, allocation and distribution process that currently involves a range of participants (see Annex 1) and every level of Bangladesh's administrative hierarchy (Box 1). However, in 2013 efforts were made to reform this process by having primary school teachers voluntarily compile the beneficiary list while under the supervision of the UNO. While this has significantly reduced inclusion and exclusion errors, the problem of accurately identifying beneficiaries continues since fishers are not always easily identifiable.

4.5 TRANSACTION AND ADMINISTRATION COSTS

4.5.1 Food compensation

The costs of running the rice compensation scheme are repeated annually and include staff salaries for the preparation of the beneficiary list, rice distribution and transportation, and administrative costs. Haldar and Ali (2014) estimate the transaction and administrative cost of distributing a metric tonne of rice for the period 2013–2014 at BDT 918 (equivalent to US$ 11.79[13]) with an overall cost of BDT 30,918 (equivalent to US$ 397) including the cost of purchasing a tonne of rice (Table 6). In 2013–2014, 36,296 tonnes of rice were distributed bringing the total cost of the rice compensation scheme to BDT 1,122,230,000 (equivalent to US$ 14,380,984). After the cost of purchasing rice, the cost of transport (from the local storage depots to the distribution yards) and project administration represent the two greatest costs (Table 6).

The cost of transport varied between geographic locations due to differences in the distance between local storage depots and distribution yards, and whether multiple modes of transport were required (Haldar and Ali 2014). Rice is then distributed to beneficiaries, which is transported home at their own expense (on average BDT 200–300), again depending on distance and mode of transport. Overall the costs of rice allocation, distribution and transport, and administration amount to 3 per cent of the total operational cost, a low proportion relative to other compensation schemes.

While the expenses of rice allocation and distribution are financed by government and from revenue generated by the sale of empty rice sacks, *upazila* chairmen end up with an average deficit of BDT 157.7 per metric tonne (Haldar and Ali 2014). The government actively encourages *upazila* chairmen to submit their expenses to the UNO office and recoup any additional loss, but to avoid this lengthy process *upazila* chairmen simply withhold an equivalent value of rice from each beneficiary. Additionally, other staff involved in the distribution chain (eg the watchman and man who weighs out the rice) also reportedly withhold rice as there is no mechanism in place for them to recoup any expenses they incur. As a result of the inconsistent quantities of rice being issued, there is a growing resentment among beneficiaries leading to reduced compliance with regulations, thus undermining the effectiveness of the scheme.

13. Based on an exchange rate of US$ 0.0013 to 1 Bangladeshi taka (BDT) which is used throughout this paper.

TABLE 6. COST OF THE FOOD COMPENSATION SCHEME

ITEM	COST (BDT PER TONNE)	TOTAL COST (BDT MILLION)	PERCENTAGE OF TOTAL COST
Food allocation	70.00	2.54	0.22
Food transport	422.00	15.32	1.37
Food distribution	126.00	4.57	0.47
Administration	300.31	10.90	0.97
SUB-TOTAL	918.31	33.33	3.00
Cost of 36,926 tonne of food	30,000	1,088.90	97.0
TOTAL	30,918	1,122.23	100.00

Source: reproduced from Haldar and Ali (2014)

4.5.2 Alternative income-generating activities

To date, 21,690 households have been supported by the AIGA scheme at an average annual cost of BDT 163,560,000 (US$ 2,089,850) providing fisher households with an average benefit value of BDT 7,540.8 (US$ 96). Relative to the food compensation scheme, the administrative, beneficiary allocation and distribution costs of the AIGA scheme amount to a considerably lower proportion (0.7 per cent) of the total operational costs, with materials accounting for 99.3 per cent of the total.

4.6 BENEFICIARY PREFERENCES

Interviewees considered compensation as a right, as evidenced by the lack of interviewees who selected the 'opt out' choice. While there was considerable heterogeneity in interviewee responses between the split samples (ie communities living inside vs those living outside the sanctuaries, and beneficiaries vs non-beneficiaries), there was a high level of consistency within samples (mean of 93 per cent) for a particular choice. The heterogeneity between the split samples suggests that the preferences of the interviewees may change over time depending on their experience. For example, interviewees who did not receive compensation did not value rice any differently from AIGA, while those who do receive compensation prefer AIGA over rice. The difference between the two groups was ascribed to the fact that beneficiaries viewed rice compensation negatively given the issue of often not receiving their full allocation (see Section 4.5.1).

The results from the study highlight implicit discounts that could be achieved through modifications to the length of the fishing bans, the frequency of compensation payments, and the type of compensation that is issued. The greatest potential cost provision comes in the form of reducing the length of the *jatka* and adult brood hilsa ban: interviewees were willing to forego compensation if the duration of the ban was reduced, but required more compensation as the ban duration increased.

Interviewees also preferred to receive compensation as a one-off or monthly compensation rather than annually. Furthermore, if beneficiaries are issued with rice rather than AIGA then the marginal willingness to accept was BDT 8.28 per household. In other words, the respondents were willing to forego BDT 8.28

of cash payment for each unit of AIGA received instead of rice. These two observations depict that the respondents have seriously considered time value of money (discount rate) and trade-offs between different options while answering the choice experiment questions.

4.7 UNINTENDED CONSEQUENCES

As noted earlier, benefit-distribution mechanisms can have a number of unintended negative impacts on the community that may not be realised until the scheme has been implemented. The impacted communities could be beyond just fishers and may include other community members who are directly or indirectly employed in the fish supply chain or even farmers and labourers who live within and adjacent to the areas of intervention. Mohammed *et al.* (2014) identified unintended negative impacts on local rice prices, the microfinance market and the local labour market. During the fishing ban, following rice distribution within the sanctuaries, rice retailers and wholesalers report a drop in sales of between 10–20 per cent, and 20 per cent respectively. Furthermore, because demand for rice is reduced, rice prices can fall by up to 10 per cent depending on the distance of sellers from the beneficiary villages.

As well as seeking an alternative income, many fishers will be forced to seek loans from local microfinance institutions and informal money lenders (known locally as '*aratdars*'). During the ban, demand for loans can increase by up to 30 per cent, forcing interest rates up by 20–30 per cent. Limited capacity financially excludes many fishers from obtaining loans with formal microfinance institutions, forcing them to seek loans from informal lenders (Uraguchi and Mohammed 2016). In order to repay debts, fishers are forced to relinquish their entire catch, 50–60 per cent of which is sold to repay the debt with the remainder being given back to the fisher in cash. However, fishers are required to continue debt repayments throughout the ban, forcing many to fish illegally.

While the food compensation can remunerate fishers for their loss of food during the ban, it does not cover the loss of dietary protein, grocery expenses or school fees etc. During the ban, many fishers and supply-chain workers flood the local labour market, seeking work as casual labourers, consequently driving down local labour wages by up to 40 per cent.

4.8 RECOMMENDATIONS

Evidence from existing direct economic incentive-based schemes highlights the importance of designing equitable benefit-sharing mechanisms for achieving local, national and international legitimacy, and supporting management activities. Since the inception of the Jatka Conservation Project in 2005, the food compensation scheme has shown a consistent annual increase in the number of households being compensated for the loss of income from restrictions on fishing activity. In 2013–2014, the government of Bangladesh successfully supported just over half of all affected households. However, results from the various studies discussed here highlight a number of project design flaws that are compromising the equitability of the current compensation scheme. In the following sections we propose a number of changes to address these equity issues.

4.8.1 Improvements to beneficiary targeting

At present, project legitimacy and support are being compromised by beneficiary mistargeting and the exclusion of particular social groups affected by the regulatory changes to the hilsa

fishery. Despite claims that the compensation scheme is targeted at *jatka* fishers, and the poorest and most fishing-dependent – or vulnerable – households, Bladon (2016) found no evidence to support this. Results from this same study suggest that targeting *jatka* fishers may not just make ecological sense – in terms of preserving the juvenile stock and thereby protecting recruitment – but may also capture some of the poorest and most fishing-dependent households, though this result must be taken in the context of considerable uncertainty in the analysis when distinguishing between *jatka* and non-*jatka* fishers.

While the strategy of targeting *jatka* fishers appears to achieve both ecological and 'pro-poor' objectives, it compromises the equitability of the compensation scheme namely within the sanctuaries where all types of fishers are impacted by the fishing ban. A more equitable approach would involve targeting the poorest and most vulnerable of all fishers. The issue of how to accurately identify fishers from non-fishers was recently addressed following the introduction of the fisher identity card.

Improving the equitability of the beneficiary selection process not only requires measures to improve the detection of fishers and non-fishers and the most vulnerable, but also efforts to reduce intentional or unintentional exclusion errors. Additional to the documented inclusion/exclusion of beneficiaries for political gain (Haldar and Ali 2014), 70 per cent of informants in Bladon's (2016) study 'perceived' that benefit distribution is biased towards the 'elite'. Efforts to reduce intentional inclusion/exclusion errors have made the process of identifying beneficiaries independent from local government and councils by employing local school teachers to compile the beneficiary list. This has also helped to improve unintentional inclusion/exclusion errors as local school teachers typically live locally and are therefore more likely to know individuals of the fisher community. Nevertheless, opportunities for intentional inclusion/exclusion errors continue to exist while local councils are involved in approving the final beneficiary list.

As mentioned earlier, compensation is currently targeted towards particular groups due to a lack of financial resources for distributing compensation to all affected households. While the food compensation scheme has successfully reached just over half of all affected households, approximately 224,000 affected households receive no compensation. Increasing the number of beneficiaries of the compensation scheme is heavily dependent on mobilising additional funds. One suggested mechanism for increasing access to funds is to reduce the transaction and administration costs of the compensation scheme. While costs are already low in relation to other similar schemes, further reductions may be achieved by simplifying the beneficiary selection process thereby reducing staff salaries, and sourcing rice locally, consequently reducing distribution costs. However, more significant increases in available funds may potentially be achieved through the establishment of a hilsa conservation trust fund, which will be discussed in further detail in Section 7.

4.8.2 Costs

Support for the hilsa management scheme is further endangered by the fact that households do not always receive their full allocation of rice compensation. To provide a consistent and complete allocation, measures are needed to ensure the costs of all actors in the allocation and distribution process – not only *upazila* chairmen – are reimbursed, thereby reducing the need to withhold rice from the beneficiaries (Haldar and

Ali 2014). Improving levels of reimbursement is contingent on finding ways to simplify the reimbursement process. Addressing levels of cost reimbursement across all actors serves to not only improve levels of compensation received by beneficiaries, but improve the equity of cost distribution.

4.8.3 Capturing changes in beneficiary preferences

Ideally, preferred and actual compensation packages should converge. However, sometimes the preferences of the recipient communities for certain compensation packages may be financially and logistically challenging (if not impossible) to deliver. Therefore, inevitably, there will be some divergence between 'preferred' and 'actual' compensation packages provided. Efforts must be made to narrow this gap. One way of doing this could be by designing financially and logistically plausible 'predetermined' compensation packages and consult recipient communities and households before decisions are made.

Moreover, the results from the beneficiary preferences study support the conclusion from earlier studies that beneficiary preferences are dynamic (change over time based on experience). In order to capture these changes, assessments of preferences must undergo periodic review to ensure alignment with the design of the compensation scheme (eg Mohammed *et al.* 2013). Failure to capture these changes may erode support for the compensation scheme and therefore regulation compliance levels.

4.8.4 Trade-offs between beneficiary preferences and scheme design

The analysis of beneficiary preferences revealed three opportunities for lowering the cost of compensation. However, each comes with a trade-off, which in the absence of a cost-benefit analysis, makes it difficult to ascertain the overall economic loss/gain.

Firstly, a reduction in the duration of the *jatka* and adult hilsa fishing bans may negate the need to issue any form of compensation but this must be balanced against the fact that shorter bans will fail to provide adequate protection to the hilsa stock, as evidenced by the recent finding that the spawning ban is in fact short (see Section 5.2 for further details). In the long term, inadequate protection of the hilsa stock will compromise the size of the hilsa stock thus impacting revenue from hilsa fishing and therefore counteracting any financial gain from not issuing compensation.

Secondly, the preference for a one-off compensation payment lowers the cost of the scheme by removing annual or monthly transaction and administration costs. However, this must be weighed against the fact there is no long-term incentive to comply with fisheries regulations. A one-off payment may be spent quickly requiring future ongoing support for those who are particularly vulnerable (Ahlheim and Neef 2006). While ongoing monthly payments may appear to be the least cost-effective option, ongoing payments may improve public support for the scheme and therefore levels of compliance (Ahlheim and Neef 2006).

Thirdly, a switch from rice to AIGA compensation could lower long-term costs as it eliminates the need for ongoing support. However, this benefit must be weighed up against the fact that issuing AIGA requires a higher overall initial cost relative to the annual cost of rice compensation, and there is insufficient evidence such an approach can effectively change behaviour (Wright *et al.* 2015).

The most effective long-term solution that could potentially achieve cost savings, meet beneficiary preferences and eliminate the need to compromise the ecological integrity of the scheme, would involve altering the type of compensation from rice to AIGA. However, the beneficiary preference for AIGA over rice is reportedly driven by the inconsistent quantity of rice that is issued. Before the economic trade-off between AIGA and rice compensation can be fully evaluated, a study is needed comparing both types of compensation under an optimally operating scheme.

4.8.5 Mitigating unintended consequences

To ensure the hilsa compensation scheme is equitable means to also account for the unintended consequences of regulatory changes and benefit distribution. As a consequence of the fishing bans, many fishers are forced to borrow money, largely from informal money lenders. Issues with informal money lenders include high interest-rate loans, and a burden on fishers to continue repaying debts throughout the fishing ban 'forcing' them to fish illegally. To mitigate this, as argued by Mohammed *et al.* (2014), microcredit services and products should be introduced and tailored to meet the needs generated by a fishing ban. This must include a 'grace period' that protects fishers from repaying capital or interest when the fishery is closed, which would in turn boost compliance with the ban. Well-thought-out microcredit should gradually liberate hilsa fishers from a cyclical debt trap and prevent the interest rates they pay rising when the fishery is closed.

Moreover, a longer-term strategy could involve the creation of alternative employment opportunities to reduce fisher reliance on loans during the ban and diversify their income sources, making them less dependent on the income from fishing. Alternative employment opportunities could involve employing fishers in monitoring and ban enforcement duties (see Section 3.4.2). This approach has been successfully used in many similar schemes and offers additional advantages including reduced monitoring costs, and increased support for regulatory changes. Similarly, increased investment in the AIGA scheme will serve to diversify fisher income sources, while also reducing dependence on the food compensation scheme and therefore costs to the government.

Fluctuations in local rice prices may be stabilised if 'in-kind' compensation is sourced locally (Mohammed *et al*. 2014). Compensation distributors should either buy local rice or issue vouchers to be redeemed against local purchases. Sourcing local 'in-kind' compensation may also serve to stimulate the local economy and lower some of the administrative costs (eg transport and distribution) of the compensation scheme.

FIVE
BIOLOGY AND ECOLOGY OF THE HILSA FISHERY

In this section, we review the findings from three separate studies exploring various aspects of the biology and ecology of hilsa fish within the *jatka* and spawning sanctuaries of Bangladesh. The objectives of this research are as follows:

- Investigate the spawning seasonality of hilsa,
- Investigate the food preferences of hilsa fish across a range of age classes, and
- Investigate the physical, hydrological, chemical and biological profile of hilsa habitat.

All three studies were carried out by a team of researchers from the Department of Fisheries Management at BAU and IIED. For the study of spawning seasonality, over a thousand specimens were collected at monthly intervals between September 2013 and August 2014 from Chandpur on the Meghna River, one of the five recognised spawning sanctuaries. The gonadosomatic index (GSI), which is a common metric for assessing sexual maturity in fish, was used in combination with observations on ovarian development to determine spawning season, the results of which have been published in Hasan *et al.* (2015).

Specimens for the study on the feeding ecology of hilsa were collected between January and December 2014 from Chandpur on the Meghna River. A gut content analysis was carried out on 318 hilsa fish, of varying size classes, and dietary preference was calculated using the Electivity Index which shows the strength of choice in a predator's feeding behaviour. The results of this study have been published in Hasan *et al.* (2015).

Data for the study on the biophysical characteristics of hilsa habitat were collected between January and December 2014 at four sites across the Meghna, Tentulia and Andermanik rivers. The results of this study have been published in Hasan *et al.* (2015).

5.1 BACKGROUND AND CONTEXT

Effective spatial management of wild fisheries relies on a sound knowledge of a species' biology and ecology. Knowledge of species' diet and habitat preferences has been used to identify optimal habitat and therefore the location of protected areas. Furthermore, information on the biology and ecology of species can be used to predict changes in species distribution under variable climate scenarios (Falke *et al.* 2013) allowing conservation practitioners to plan for and mitigate the negative effects of climate change. Management tools such as fishing bans often seek to preserve species during a critical life phase. For example, implementing fishing bans during spawning events is a commonly used management measure for preserving the breeding stock and maximising recruitment (Grüss *et al.* 2014).

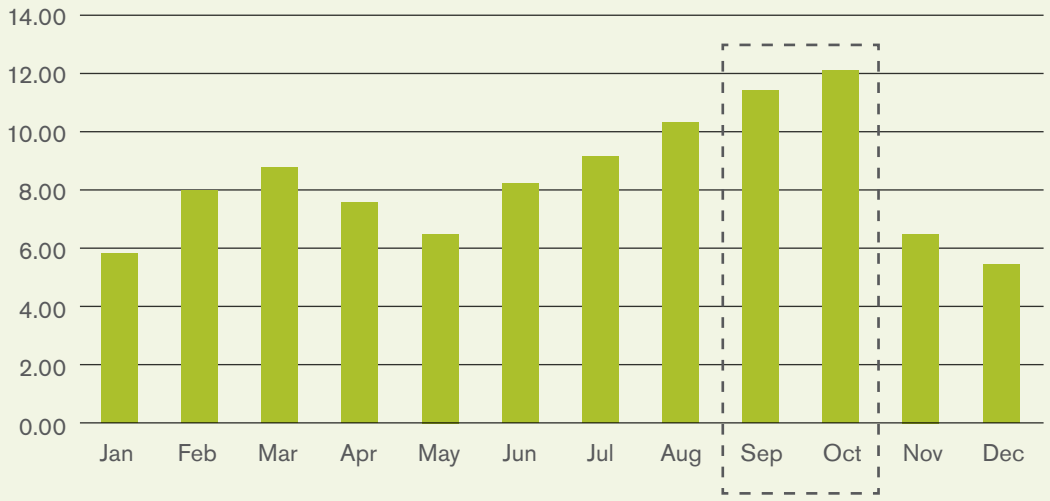
Every year, hilsa fish undergo large-scale migrations from the coastal waters of the Bay of Bengal to spawn in the river systems throughout Bangladesh. Historical data indicates that these major spawning events occur during the Bengali month of *Ashwin* (October), 5 days before and after the full moon (Rahman *et al.* 2012). However, more recent observational data suggests that the existing 11-day fishing ban in October may not adequately capture the timing and duration of these spawning events. Furthermore, there are growing concerns that given the dramatic effects of climate change on the coastal and riverine ecology of Bangladesh, that the seasonality of spawning and the location of optimal habitat might

undergo significant annual shifts (Bladon 2016; Miah 2015). While there has been considerable research on the biology and ecology of hilsa in India there has been comparatively less within Bangladesh, prompting the need for research on spawning seasonality, food and feeding ecology, and habitat preferences to support ongoing adaptive management.

5.2 SPAWNING SEASONALITY

The results of the study by Hasan *et al.* (in prep) largely corroborates findings from earlier studies showing that hilsa achieve sexual maturity by October. However, Hasan *et al.* (in prep) also found that data on the GSI indicated that the peak spawning period for hilsa in the Meghna River may start a few weeks earlier in late September and continue for up to 20–25 days before dropping again in late October (Figure 5). Nevertheless, it must be acknowledged that this study was based on data from a single year and a single location. Migratory fish within the West Bengal region can show considerable variability in the timing and duration of spawning in response to climactic factors – such as rainfall and water temperature – and flow rate (Sharma *et al.* 2014), leaving some uncertainty regarding the level of inter-annual variability in the duration and timing of spawning in hilsa under a rapidly changing climate.

FIGURE 5. MONTHLY CHANGES IN THE GONADOSOMATIC INDEX (GSI) OF FEMALE HILSA



Source: Hasan *et al.* (in prep)

5.3 FEEDING ECOLOGY AND BIOPHYSICAL ASSESSMENT OF HILSA HABITAT

The results of the study by Hasan *et al*. (2015) demonstrate that hilsa are largely planktonic feeders with a preference for phytoplankton over zooplankton. This is evidenced both by the gut content analysis and the peak in *jatka* abundance in the Chandpur area between January and April which coincides with the peak in plankton abundance. While extensive biophysical assessments have been carried out of the hilsa habitat within the sanctuaries, comparable assessments of non-hilsa habitat and at different times of year have not been undertaken making it difficult to ascertain why there is a higher abundance of plankton and hilsa within the sanctuaries.[14]

The results of the biophysical assessment study showed that water quality was largely suitable for fish at all sanctuary sites, except the Andermanik River where there were significantly higher levels of ammonia and nitrogen which are likely to influence the migration of hilsa upstream. Furthermore, in the lower reaches of each of the rivers significant sandbars and submerged islands were identified. In the absence of efforts to preserve sufficiently deep river channels, sandbars and submerged islands may present a major barrier for hilsa migration.

5.4 ISSUES TO CONSIDER

5.4.1 Timing and duration of spawning

The recent study exploring spawning seasonality of hilsa in Bangladesh indicates that spawning may occur earlier and for longer than previously supposed. In response to this conclusion, the government of Bangladesh recently extended the spawning season fishing ban from 11 days to 15 days (three days before and 11 days after the full moon). While the new ban period does not fully account for the likely duration of spawning activity, fishers are not currently compensated for the loss of earnings during the spawning season ban given its short duration. An extension of the fishing ban to 25 days will require that fishers are adequately compensated for their loss of earnings and food during this period (Mohammed and Wahab 2013). At present, there is no mechanism in place to financially support a compensation scheme for the spawning-season fishing ban but this could be overcome with the establishment of a hilsa conservation trust fund (see Section 7 for further details).

There remains some uncertainty regarding the level of inter-annual variability in the timing and duration of spawning given the limited duration of this study and the rapidly changing climate within Bangladesh. To improve the predictability of spawning timing and duration for fisheries management will require further studies like this

14. According to Hasan *et al.* (2015) plankton abundance is affected by a number of biological, physical and chemical parameters such as wind-induced mixing, high light influx, temperature, water depth/level and/or salinity. Plankton abundance can be easily affected by anthropogenic factors such as siltation and pollution, which pose a threat to hilsa sanctuary and habitats. This suggests a need to promote intersectoral coordination with eg land-based activities that may affect the habitat.

over a longer time period and at a greater number of sites. As mentioned in Section 3.1, the DoF currently has limited capacity for expanding its research activities. While the establishment of a hilsa conservation trust fund may increase the scope of the DoF, employing the use of local people as data collectors may present a low-cost solution to increasing monitoring capacity (see Section 3.4.2 for further details).

5.4.2 Limitations of hilsa spawning and migration

While threats acting independently of one another may pose little danger to a species, threats acting synergistically can significantly increase rates of decline. For example, fishing pressure can magnify the effects of climate change on populations of aquatic invertebrates (Harley and Rogers-Bennett 2004). Similarly, aquatic pollution coupled with increasing global temperatures can increase disease prevalence in fish populations (Karvonen *et al*. 2010), impeding their recovery even in the absence of other threats. While the impact of aquatic pollution on hilsa is not fully understood, numerous studies have demonstrated reproductive impairment in fish exposed to high levels of pollutants (eg Wu *et al*. 2003; Scott and Sloman 2004). Coupled with the growing threat of increasing global temperatures due to climate change, aquatic pollution may impede the recovery of hilsa even in the absence of fishing pressure.

Industry represents one of the biggest sources of pollution, particularly in the Andermanik River. While government policies prohibiting the dumping of untreated industrial waste into aquatic systems have been enacted, many industrial plants either lack effluent treatment plants (ETPs) or fail to run them due to high implementation/ running costs (Khan *et al.* 2009). Furthermore, regulations are poorly enforced due to a lack of enforcement capacity (Asian Development Bank 2004). Nevertheless, even where penalties are issued, they are typically not severe enough to promote compliance with environmental legislation (Begum 2015). Efforts are needed to enact policies that address this inequity.

Similarly, sandbar formation due to siltation and submerged islands represent potentially significant barriers to hilsa recovery by blocking key migration routes. Continued damming, upstream dredging and loop-cutting, and reductions in freshwater flow will only exacerbate these issues further. In the short term, dredging may be required to ensure migration is unobstructed by these physical barriers, but this does not negate the need for long-term strategies to mitigate the causative factors of siltation.

Development of targeted conservation actions for the preservation of hilsa habitat and food (ie plankton) is also going to require further studies examining the unique biophysical characteristics of the hilsa sanctuaries. This will require biophysical assessments of not only hilsa habitat, but non-hilsa habitat and across different seasons to improve understanding of the characteristics that underlay the temporal and spatial patterns in hilsa and plankton abundance.

SIX
TRANSBOUNDARY APPROACH TO HILSA FISHERIES MANAGEMENT

Migratory species are rarely distributed within political boundaries, thereby demanding transboundary cooperation for their conservation. Transboundary cooperation improves the effectiveness of conservation schemes by reducing the need for duplicated research effort, increasing effort to tackle wide-scale threats, and improving national support for the scheme (Erg *et al.* 2012). However, fostering transboundary cooperation is rarely straightforward, particularly where there are competing environmental objectives, and diverse legal and institutional governance structures (Erg *et al.* 2012), and so requires forums in which to facilitate dialogue between the various stakeholder groups.

Hilsa shad are known to occur in the coastal marine and freshwater habitat of countries spanning from Vietnam to the Persian Gulf (Freyhof 2014). Despite their broad distribution, the majority of the global hilsa catch is taken by Bangladesh (50–60 per cent) with relatively smaller proportions taken by Myanmar (20–25 per cent), India (15–20 per cent) and other countries (5–10 per cent) (Rahman *et al.* 2012). Observed declines in the annual catch of hilsa within the Bay of Bengal region have prompted wide-scale conservation efforts by the Bangladesh government (Mohammed and Wahab 2013). Despite these attempts, the threats to hilsa (ie overfishing of *jatka* and brood hilsa, siltation, loss of habitat, water-management projects and pollution) are common to all countries in which hilsa occur, jeopardising conservation efforts carried out by Bangladesh alone. For example, efforts to preserve unobstructed channels for spawning migrations in Bangladesh are compromised by the presence of dams and barrages in India (eg the Farakka Barrage), as well as deforestation and river mining (Ahsan *et al.* 2014).

In recognising the need for cooperation between India and Bangladesh for the management of natural resources, in 2010 the International Union for Conservation of Nature (IUCN) established the Ecosystems for Life initiative, an institutional framework that coordinates multi-stakeholder research and dialogue on transboundary issues. In 2014, the Ecosystems for Life initiative published a report on the transboundary issues for hilsa management in India and Bangladesh, in which they highlighted the need for inclusion of Myanmar in hilsa conservation action planning given their significant impact on the fishery (Sinha and Ahmed 2014).

The Darwin Initiative-funded project will build on existing momentum and create a platform for regional cooperation. This is done by sharing lessons from the Bangladeshi experience and exploring ways this could be scaled up to regional level. However, there are two main challenges that may hinder the realisation of regional incentive-based hilsa management: the lack of a regional institutional framework, and the lack of financial capacity to administer such a large-scale regional initiative. One way of filling both institutional and financial gaps is the establishment of a regional hilsa foundation, which builds on a proposed trust fund for Bangladesh, which is discussed in Section 7.

SEVEN
HILSA CONSERVATION FOUNDATION

7.1 DESIGNING AN APPROPRIATE CONSERVATION FUND

An increasing human population has placed an increasing pressure on aquatic resources and the ecosystem services they provide. The value of maintaining good aquatic health for the benefit of humans is evidenced by the increasing efforts of governments globally to implement policies that achieve ecological sustainability. Efforts to accomplish or improve ecological health involve regulating access to and extraction of resources. However, given the reliance of many communities on these resources, particularly within developing countries, natural resource users need to be compensated for their loss of earnings to incentivise regulatory compliance.

For many countries, adequate financing mechanisms remain a considerable challenge for the long-term sustainability of natural resource management schemes (Balmford and Whitten 2003; Hein *et al.* 2013). Examples of commonly used instruments for sustainably financing natural resource management include fiscal reforms,[15] incentive-based schemes and conservation trust funds (CTFs).

In recent years there has been growing interest in the use of tools such as CTFs, also known as environmental funds, of which there are more than 70 in existence globally (Bladon *et al.* 2014; Conservation Finance Alliance 2008). Conservation trust funds are private, legally independent institutions that mobilise and invest funds from a variety of sources, including the private sector, government and international donors for the purpose of financing natural resource management (Bladon *et al.* 2014; Conservation Finance Alliance 2008). Additionally, CTFs can initiate and improve resource management agencies' relationships, procedures and capacity (Bladon *et al.* 2014; Conservation Finance Alliance 2008). A CTF may be particularly valuable in situations where institutions lack the capacity and efficiency to make use of available funds, where there is political instability, or where private-sector funds are available (Bladon *et al.* 2014).

Despite their growing prevalence, the implementation and management of CTFs is complex, lengthy and often tedious. Their complexity and the requirement for a large investment of funds require that an initial assessment phase be undertaken to determine if a CTF is the most appropriate financing option given the requirements and resources of a country. Furthermore, there is no panacea to designing and managing a CTF that will address inherent economic and political differences between host countries. While adhering to the design criteria for a CTF may help to overcome some of these differences (Box 2), design procedures ultimately need to be adaptable and tailored to the country in question.

15. The use of taxes, fees or subsidies as incentives or disincentives for particular behaviours.

BOX 2. DESIGN CRITERIA FOR A CONSERVATION FUND

There are many factors that can influence the success of a CTF, such as design and management procedures, as well as external factors such as the economic and political environment (Bladon *et al.* 2014). Based on a recent review of 12 existing CTFs at varying stages of maturity (ibid), the following have proven useful criteria against which to design an effective CTF.

1. Carry out a **feasibility analysis** to assess the suitability of a CTF. As CTFs can tie up investment over the long term and generate relatively low levels of return, they are better suited to projects requiring a long-term and continuous response. A CTF should also be able to meet the preconditions set out below (GEF 1998).
    a. Long-term government support
    b. A group of stakeholders with a common vision willing to come together for the creation and implementation of the CTF
    c. A demand for funds from capable implementing agencies
    d. The existence of, or possibility of quickly establishing, a basic legal and financial framework
2. The CTF should have a **clear focus**, demonstrating not only financial success but also **conservation value**.
3. CTF **governance should be diverse and participatory**, balancing autonomy with political support.
4. The design process should incorporate **strategic partnerships** for mentorship and financial and technical assistance.
5. A **diverse financing mechanism** is critical for buffering the CTF against fluctuations in revenue from a single source.
6. Clearly defined standards for **reporting, monitoring and evaluation** that operate at all administrative levels of the CTF, ensuring transparency and an adaptable approach to management that responds to institutional performance and conservation outcomes.

7.2 ESTABLISHING A HILSA CONSERVATION TRUST FUND

Throughout the course of this paper we have highlighted a number of areas in which a lack of funding has impacted the effectiveness of hilsa management: a lack of resources for ecological monitoring; a lack of resources for effective policing, monitoring and enforcement of fishing regulations; a lack of capacity for research on stock management and diversification of fisher livelihoods; a need for increased awareness-raising programmes and public support campaigns; and lack of capacity for transboundary hilsa stock management. Given the significant annual revenue from the hilsa fishery (US$ 630 million) and the significantly lower cost of compensating fishers for hilsa fishery bans (BDT 1,238.73 million or US$ 15.771 million), there is a clear economic argument for continuing hilsa management. The development of a hilsa conservation trust fund – the Hilsa Conservation Foundation (HCF) – has been proposed as a mechanism by which to address many of the current hilsa-management financing issues. The benefits of a hilsa CTF extend beyond addressing capacity and resource inadequacies, but could support the wider development of an institutional framework for fisheries governance (Majumder *et al.* 2015a).

In 2015, a multi-stakeholder workshop was held in which the requirements and structure of a hilsa CTF were discussed. Based on the findings of this workshop, the following have been proposed as primary objectives of a hilsa CTF:

- To ensure sustainability of the compensation scheme and to increase the number of hilsa fishers benefiting from the scheme (see Majumder *et al.* 2015a for further details on the financial requirements of the hilsa CTF).
- To ensure wider coverage of hilsa fishers affected by the ban period and zone.

- To ensure equitable distribution of benefits from hilsa conservation, management and development.
- To initiate actions and promote restoring and conserving the hilsa habitat in the riverine and marine environments. In addition to protecting critical hilsa spawning habitat, expansion of the Bay of Bengal MPA would help Bangladesh meet Target 11 of the Convention on Biological Diversity (CBD) which aims for all signatories to protect 10 per cent of marine habitat by 2020.
- To develop and implement alternative livelihood activities for the hilsa fishers for the conservation of *jatka*, gravid hilsa and hilsa habitats.

Here we review the findings from the 2015 multi-stakeholder workshop in which the suitability and requirements for establishing a hilsa CTF were explored, and discuss the enabling and limiting factors for a hilsa CTF.

7.2.1 Financing options

Two of the pre-conditions for establishing a conservation trust fund are a source of seed money, and a means for continued finance generation for the duration of the fund. Conservation trust funds typically take one of three financial structures depending on the size and requirements of the CTF (Bladon *et al.* 2014; GEF 1998). Endowment funds use the income (ie interest or return) on investment only to fund activities. They are best suited to long-term projects as they tie up a large sum of money generating a relatively low rate of interest. Sinking funds distribute a portion of the capital over a fixed period of time, until the fund sinks to zero and are therefore best suited to relatively short-term projects. A revolving fund is continually replenished, usually with user fees or earmarked taxes which are used to finance project activities. If the source of revenue is unsustainable and is disbursed more quickly than it is replenished, the fund will collapse and so part of the revenue is often set aside for establishing an endowment fund (see Bladon *et al.* 2014 for a full review of the advantages and disadvantages of each type of fund).

In considering that hilsa management activities require a long-term, sustainable source of funds an endowment fund[16] has been proposed as the most suitable source of fund generation. Furthermore, a diverse set of funding sources has been identified (Box 3) to buffer the hilsa CTF against potential fluctuations or the loss of a single source of funding (Bladon *et al.* 2014).

16. Where the financial assets of a fund are invested and only the income from this investment is used to finance activities.

BOX 3. FINANCING OPTIONS FOR THE HILSA CONSERVATION FOUNDATION

1. Earmarking hilsa export tax revenue

The government of Bangladesh earns a significant amount of money from hilsa exports. According to some estimates, the revenue is as high as US$ 160 million (Mome 2007). Therefore, it is financially plausible to earmark a small percentage (between 5 to 10 per cent) of the revenue and channel it to the fund. However, it should be noted that given the limited resource base of the government for carrying out other development work, this puts an additional pressure on the government. The tax to GDP ratio of the country is very low when compared with neighbouring countries. Therefore, it may be difficult to earmark tax revenue for the conservation fund. However, government contributions may be needed only once (seed money), and then the fund would continue to generate financial resources through alternative means without relying (heavily) on government budgets.

2. Debt service liability

Debt service liability means repayment of principal and interest by the government for a loan from development partners. This is similar to a 'debt swap' scheme, where creditors write off all or part of the debt, under the condition that the same amount of resource is directed towards investment in other development or conservation projects. There are a number of examples from Latin America and the Caribbean, where a number of conservation funds have been established through mutually agreed terms between indebted governments and creditors, most notably USAID. Similar examples can also be found in Bangladesh, such as the Krishi Gobeshona Foundation (KGF) and the Silk Foundation Fund.

3. Introducing fees to beneficiaries

An alternative financing option is to introduce fees to beneficiaries along the hilsa supply chain. To do so, a careful assessment and mapping of the chain is needed. The value-chain actors may include middlemen, processors, storage facilities, exporters or even local distributors and consumers, such as hotels, restaurants and other service providers in the tourism sector. Fees may be collected in the form of taxes or other means.

4. Existing climate funds

There are several funds available for combating climate change impacts. Climate change has an adverse impact on all kinds of fisheries and the diminution of hilsa fish production has also been considered a consequence of climate change impacts. Funds can therefore be solicited from the Bangladesh Climate Change Trust (BCCT), the World Bank's Bangladesh Climate Change Resilience Fund (BCCRF) and other international sources of climate change funds such as the Green Climate Fund (GCF).

5. Deposit in a fund with a fair dividend rate (FDR)

A fund with a fair dividend rate (FDR) is the most traditional and less risky method of investment. Currently, the interest rate for a fixed or term deposit approved by the Bangladesh Bank is 12 per cent. A sizable amount of the seed capital can be deposited with a registered bank as a term or fixed deposit. CAMEL ratings (capital, assets, management capability, earnings, liquidity and sensitivity) can be used to identify suitable banks for the investment of funds to ensure maximum return commensurate with risk. The endowment funds of organisations such as the Bangladesh Institute of Development Studies (BIDS), the BCCT and the Civil Service College are being used as FDRs for earning income for organisations.

7.2.2 Governance and institutional structure

Governance of the proposed hilsa CTF would be carried out under a two-tier system comprised of a board of governors at the top level to provide overall strategic direction and guidance, and local government committees at the lower level to oversee the work programme and ensure that activities are carried out in accordance with agreed procedures. The proposed board of governors would comprise top-level representatives from the major government ministries, non-governmental organisations (NGOs), the private sector, and fishermen's associations (see Majumder *et al.* 2015b for further details) to ensure political autonomy but also to gain political support.

Similarly, to ensure transparency in the governance of the trust, a variety of protocols have been designed to ensure there are mechanisms in place for internal and external audits, and financial reporting (see Majumder *et al.* 2015a for further details).

7.3 ISSUES TO CONSIDER

Throughout this paper we have highlighted a number of areas in which inadequate funding is compromising the efficacy of hilsa management. A hilsa CTF could not only overcome these funding deficiencies but also provide a sustainable revenue stream for hilsa management, buffered against political and economic disturbances.

7.3.1 Buffering revenue against economic instability

To ensure a CTF is buffered against economic fluctuations, it is important to have a diverse financing mechanism which reduces reliance on a single source of revenue (Bladon *et al.* 2014). During the workshop, seven potential sources of revenue were identified (Section 7.2.1). While the proposal for an endowment fund may attract less donor support, Majumder *et al.* (2015a) propose a shift away from donor support towards sources such as earmarked taxes and user fees which can provide a large and predictable source of revenue. While there is an emphasis on revenue sources from ecosystem service users, donor support should not be entirely discounted. Donor support may be obtainable from one of the many climate change funds within Bangladesh given the potential climate impacts on the hilsa fishery (see Section 5.4.2 for further details).

7.3.2 Demonstrating conservation value

Conservation trust funds need to demonstrate a clear focus and conservation value to ensure effective allocation of resources, and accountability to donors and potential investors (Bladon *et al.* 2014). Achieving these goals is contingent on the availability of robust underlying data and optimal monitoring methods that are able to detect change in the factor of interest. In 2005, the government of Bangladesh published the HFMAP (see Section 2.2. for further details) which outlines key activities for hilsa conservation based on years of research by the DoF and BFRI. While there were questions over the accuracy of some of this data, recent studies have addressed many of these knowledge gaps (see Section 5 for further details). However, as is often the case with CTFs, there is a lack of detail regarding the most appropriate monitoring tool for determining the conservation value of interventions. Despite claims that the imposed fishing bans have increased hilsa landings and the availability of adult size classes (see Section 8 for further details) there is little evidence from rigorous monitoring programmes. Addressing monitoring deficiencies will require an evaluation of the most appropriate indicators for each of the conservation objectives, and the most effective tools for detecting change in each of these indicators.

7.3.3 Institutional framework to support fund establishment and governance

As stated in the memorandum and articles of association (MoA) (Majumder *et al*. 2015b), the hilsa CTF board of governors would comprise a mix of high-level government representatives from the each of the ministries, and representatives of fishing associations, NGOs and the private sector. A diverse board with representatives from all stakeholder groups and without a government majority achieves political autonomy, protecting against potential bureaucracy, improving adaptability, increasing national legitimacy, and buffering governance of the CTF against political agendas (Bladon *et al.* 2014). However, involvement of high-level government representatives on the CTF board should help to gain political support and therefore help to achieve permanence (Bladon *et al.* 2014). Furthermore, a board comprised of government representatives will ease the process of creating new legal tools necessary for the establishment of the hilsa CTF.

EIGHT
CONCLUSIONS

Since its establishment in 2005, Bangladesh's hilsa fishery economic incentive-based mechanism has achieved a number of successes. In 2013–2014, 226,852 fishers were issued with food compensation, a number that has steadily increased year on year. There have also been reports of positive ecological changes such as larger hilsa-dominating catches (Rahman *et al.* 2012); increased diversity of other aquatic species within the sanctuaries (Mohammed and Wahab 2013); an increase in the size of the brood stock (Rahman *et al.* 2012); increased egg and fry production (Rahman *et al.* 2012); and of positive social impacts such as increased income from the increase in hilsa catch (Habib pers. comm. in Mohammed and Wahab 2013); diversification of income sources and a diminished reliance on money lenders through the assistance of the AIGA programme (Mohammed 2013); and increased social time with friends and family (Jaher pers. comm. in Mohammed and Wahab 2013). In spite of these reported successes, the studies carried out as part of this paper highlight inadequacies in the design of the hilsa management scheme that are limiting the scheme's legitimacy and efficiency.

8.1 SUMMARY OF THE LESSONS LEARNT

8.1.1 Equitable benefit and cost sharing

One of the principal social challenges for the hilsa management scheme has been designing a compensation scheme that is both equitable and economically efficient. Recent research by Haldar and Ali (2014), Bladon (2016), along with earlier research by BCAS has highlighted the challenges both with identifying beneficiaries and ensuring costs are distributed equitably. At present, benefits are subject to elite capture, and costs are often borne by those who can least afford it. Based on this research, the Bangladesh government has recently moved to address equity issues with the introduction of fisher identity cards, and the involving of non-government officials in the beneficiary selection process. While these efforts should overcome many of the equity issues discussed here, rigorous monitoring and evaluation protocols are needed before conclusions can be drawn on the efficacy of these measures.

8.1.2 Improving capacity and resources for enforcement and research

In sections 3, 5 and 6 numerous studies demonstrate how major deficiencies in staff capacity and resources, particularly within the DoF, are compromising the government's ability to carry out regulatory enforcement operations and crucial research. A plethora of examples from the global fisheries community highlights the potential value to be gained from decentralising at least some of the management of the hilsa fishery, including improved compliance with fishery regulations, reduction in transaction and administration costs, increased awareness of regulations and improved institutional frameworks which could enhance communication between government and other stakeholder groups.

Similarly, enhancing levels of engagement between the government and the fisher community, and other neighbouring countries could serve as a useful tool by which to address staff capacity deficiencies within the DoF for carrying out data collection and monitoring. These deficiencies are compromising the degree to which the DoF can carry out key monitoring activities and therefore the quality of the science that underpins management strategies such as the location of spawning grounds, and the timing of brood stock bans. However, efforts to increase the resources available to the DoF need to not

only account for the current research deficiencies (eg impact of pollution, physical migration barriers) but the increased future challenges that are likely to face the fishery from climate change.

8.1.3 Sustainable financing

While limited finances underlay many of the issues discussed here, numerous data sources on annual revenues and ecological impacts suggest that financial investment in the hilsa fishery will pay dividends economically and ecologically. Overcoming the many financial challenges for the hilsa fishery depends on identification of means by which to provide increased and sustained financing that is free from economic and political shockwaves. In Section 7 we discussed the many enabling factors that could support the establishment of a hilsa conservation trust fund (CTF) that would provide a long-term source of funds for increasing the number of compensation beneficiaries; ensure equitable distribution of benefits; ensure wider coverage of the ban period and protection zones; support critical ecological research; and, aid the development of long-term alternative livelihood strategies. The next steps involved in getting a hilsa CTF established ultimately depend on the development of a diverse financing portfolio; demonstration of the conservation value of the fund through rigorous monitoring and evaluation protocols; and, development of the institutional framework to support fund establishment and governance.

8.2 WHERE TO FROM HERE?

Based on the various studies discussed in this paper, there are two issues that continue to hinder the knowledge base that supports hilsa management: robust reporting, monitoring and evaluation protocols for identifying and responding to knowledge gaps, and data on the non-fishing related stressors. Overcoming these issues will not only improve the evidence base upon which to make management decisions, but demonstrate the legitimacy and effectiveness of the hilsa management scheme to donors and the international fisheries community.

8.2.1 Reporting, monitoring and evaluation

Given the dynamic spatial and temporal complexity of ecosystems, it follows that effective natural resource management requires a well-designed and adaptable set of protocols for reporting, monitoring and evaluation that can detect and respond to these changes. The dynamic nature of natural resource management is clearly illustrated in many of the socio-economic and ecological constituents of the hilsa fishery management action plan. In Section 4.4, we have shown how experience affects beneficiary preferences and discussed how, if unaccounted for, this may diminish support for the compensation scheme over time. In Section 5.2 we have noted the potential for climate change to impact hilsa distribution and the timing of spawning events, and the importance of capturing these changes for defining the boundaries of sanctuaries and spawning season fishing bans. While the results of this project have enhanced our understanding on many aspects of the hilsa management scheme, they also demonstrate the need for ongoing rigorous reporting, monitoring and evaluation to address outstanding knowledge gaps and capture future inevitable changes.

Rigorous reporting, monitoring and evaluation protocols also serve to demonstrate the effect of interventions such as the impact of fishing bans on hilsa abundance. Evidence of positive conservation outcomes can be used as a tool for enhancing national support for management schemes and consequently enhancing compliance with regulations, as well as attracting donor support for a hilsa CTF. However, our ability

to detect conservation outcomes is only as good as the tools we use for monitoring. For example, inferences about changes in hilsa abundance from data on landings are complicated by a lack of concomitant data on fishing effort (eg number of fishers, time spent fishing, changes in gear type). Similarly, reports of positive ecological and socio-economic outcomes associated with hilsa management must be treated with caution given the absence of baseline data against which to evaluate these effects. To enhance the effectiveness of future monitoring programmes, efforts are needed to identify appropriate monitoring tools with sufficient power to detect change, along with systematic, statistically robust monitoring programmes.

8.2.2 Managing non-fishing-related threats

When the HFMAP was first developed, efforts towards mitigating the declines in hilsa catch were entirely focused on banning fishing activity in key areas at certain times. However, outputs from this project have highlighted a number of direct and indirect threats that are compromising the recovery of the hilsa fishery:

- The presence of illegal fishing activity (see Section 3.3),
- A lack of physical and staff resources for carrying out enforcement operations (see Section 3.4.1), and
- Siltation and pollution of critical hilsa habitat (see Section 5.4.2).

Based on the data presented here, we cannot be sure as to the contribution of each of these threats to overall rates of decline. But given the significant number of fishers who continue to fish illegally (see Section 3.3) and the potential for threat impacts to be magnified under scenarios of multiple interacting threats (see Section 5.4.2) at the very least studies are needed to better understand, and therefore assess, the likely impact of these threats.

8.2.3 Improving understanding of the impact of threats

Understanding the levels and reasons behind illegal behaviours is important in developing interventions and effective policies to improve compliance, but remains a significant challenge for conservationists as rule breakers are typically unwilling to disclose information on illegal/sensitive topics for fear of punishment (Keane *et al.* 2008; St John *et al.* 2010). Illegal hilsa fishing potentially poses a significant threat to the recovery of the hilsa stock, with cases of illegal *jatka* fishing activity reportedly on the increase (see Section 3.3). Furthermore, it is likely that the proportion of fishers who reportedly fish illegally, as determined during the interviews, was significantly underestimated due to the probable under-reporting of illegal behaviours. Throughout this paper we have uncovered a number of explanations for the compliance issues in the hilsa fishery (ie debt entrapment, compensation is not offered to all affected by the fishing bans, disparity between compensation type and beneficiary preferences). We have proposed a number of strategies for overcoming these issues. It is imperative that enforcement policies seek to address these compliance issues as enforcement alone may only exacerbate poverty and promote negative perceptions of the regulatory scheme.

While the studies described in this paper have uncovered a number of drivers of illegal hilsa fishing, these are restricted in their geographic scope (ie confined to a few interview sites). Research is needed to determine the degree of spatial heterogeneity in these drivers. Furthermore, given the limited resources available for enforcement activities, efforts are needed

to identify non-compliance hotspots allowing enforcement patrols to concentrate their efforts more efficiently. As noted earlier, studies of compliance issues are complicated in terms of eliciting truthful reports from rule breakers. However, in recent years, a number of tools have been developed for obtaining accurate estimates of illegal harvest levels and understanding compliance issues (see the following for further information: Nuno and St John 2014; Nuno *et al.* 2013; St John *et al.* 2010). These could provide a rapid, low-cost assessment of non-compliance hotspots and drivers allowing government to carry out targeted enforcement patrols, and develop effective policies.

8.2.4 Cross-sector coordination and cooperation

To instigate policy change that addresses these non-fishing-related threats will require coordination and cooperation across all sectors that impact hilsa management and habitat. Facilitating cross-sector discussions can help to identify where there are divergences in the mandates of each sector and therefore potential for conflicting policies. Given the recognised importance of cross-sectoral collaboration for natural resource management, the following design principles provide a useful framework by which to improve cross-sectoral collaboration and policy integration. These originate from a study by Roux *et al.* (2008) looking at the lessons learnt from the initiation and facilitation of cross-sector cooperation for the conservation of freshwater systems in South Africa. These lessons are particularly suited to the hilsa scheme given the commonalities between each scheme: scarcity of skilled people; and where economic development, job creation and provision of basic services take precedence over conservation.

Firstly, the process of environmental policy integration and ensuring policy is informed by the best available science provides a platform upon which to develop inter-sector dialogue and negotiation. The integration of science into the policy domain often fails due to a weak institutional setting: overcoming this issue requires reasoned negotiations among the various actors. Furthermore, discussions concerning what constitutes the best available science can help to foster a research-driven environment that seeks to answer critical research questions for more effective natural resource management. Secondly, enabling cooperation can incur costs for the actors involved and so requires a skilled, independent boundary-spanning agent to facilitate discussions and negotiations. The agent would preferably come from a sector on the boundary of science and policy, and who therefore has an understanding of the commonalities and differences between each sector which will help in achieving a common vision and goal. Thirdly, the goals developed during informal cross-sectoral discussions need to be integrated into formal policy and management processes. This is best carried out by a lead agency as reliance on a single individual can be risky. Given the long time period over which it takes to establish cross-sectoral cooperation and integrate policies, actors and funding should be viewed as long-term commitments to ensure the permanency of the scheme.

ANNEX 1. BENEFICIARY-SELECTION PROCESS FOR FOOD AND AIGA SUPPORT

FOOD-BENEFICIARY SELECTION PROCESS	AIGA-BENEFICIARY SELECTION PROCESS
Step 1. The Upazila Fisheries Officer (UFO), in consultation with the Upazila Nirhabi Officer (UNO), writes an official letter to every Union Parishad Chairman (UPC) in the *upazila*, requesting an incentive recipient list of genuine *jatka* fishers only. **Step 2.** The UPCs, in consultation with their union council members, prepare a list of *jatka* fishers who are eligible to receive food incentives. The chairmen organise two or three meetings to finalise the list with the Union Parishad VGF Committee, which consists of 12 UP members and 8 others and usually includes the UFO or his/her representative. After finalisation, the list of beneficiaries is submitted to the relevant UFO. **Step 3**. After receiving the lists from each UPC, the UFO asks the UNO to call together the Upazila VGF Committee to compile a list of beneficiaries for the whole *upazila*. The committee has 15 members, and 22–24 people attend including the UPCs. It usually takes two to three meetings to finalise the list, taking into account the fishers' dependency on *jatka* and their socio-economic status such as income level. **Step 4**. Having compiled the list, the UFO prepares a summary of the food incentive requirements for the *upazila* and sends it to the relevant District Fisheries Officer (DFO). **Step 5**. The DFO compiles a list of food-incentive beneficiaries from the various *upazilas* in the district and calls a District VGF Committee meeting, chaired by the Deputy Commissioner (DC) – this is approximately a 30-member committee including all UNOs and the representatives of higher-ranking officials. The list of beneficiaries is discussed, endorsed and sent to the Director General of the Department of Fisheries. Usually, the District VGF Committee does not change the list but simply endorses it and passes it on. **Step 6**. The final list of incentive beneficiaries from all the districts is compiled at the Director General's office. From there, a letter allocating the food incentives is sent to the Ministry of Fisheries and Livestock. **Step 7**. The Ministry of Fisheries and Livestock endorses the list and the amount of food grain required, forwarding it with a requisition request to the Ministry of Disaster Management and Rehabilitation.	**Step 1**. The director of the Jatka Conservation Project, based in Dhaka, writes to the Ministry of Fisheries and Livestock (MoFL) requesting funds to deliver the year's AIGA programmes. After receiving the funds release order from the ministry (which divides funds between the *upazilas*) the director approves the funds to be disbursed to the chief accounts officer of MoFL, with copies to the Director General and deputy directors of finance, planning and other relevant divisions, and to the Department of Fisheries' Districts and Upazila Fisheries Officers, including Upazila Accounts Officers. The project director also instructs the officers to deliver AIGA support programmes to the poorest fishers. **Step 2**. On receiving the funds release order, the Upazila Fisheries Officer asks the relevant AIGA UPCs to prepare a list of beneficiaries through the local Union Project Implementation Committee (UPIC). **Step 3**. Each UPC meets with the local UPIC to compile a list of beneficiaries, taking into account the scope, capacity and interest of the poorest fishers, and submits it to the UFO with minutes of the UPIC meeting(s). The UPIC consists of five members: the UPC, the UFO field assistant, a representative from the National Fisheries Cooperative and the Small-Scale Fishery Society, and one member of the UP nominated by the chairman. **Step 4**. The UFO meets with the UPIC, of which he is also member secretary. It has eight other members: the UNO, Upazila Assistant Officer (UAO), Assistant Commissioner (AC) for land, Upazila Livestock Officer (ULO), Upazila Social Service Officer (USSO), Upazila Cooperative Officer (UCO) and representatives from the National Fisheries Cooperative Society and Small-Scale Fishery Society. This committee finalises the lists of AIGA beneficiaries from each UP, taking budget allocation into account as well as the fishers' potential and capacity. **Step 5**. The UFO then prepares detailed specifications of materials to procure for the beneficiaries (such as sewing machines or livestock) and invites tenders to supply them, following the government's public procurement rules.

FOOD-BENEFICIARY SELECTION PROCESS	AIGA-BENEFICIARY SELECTION PROCESS
Step 8. The Ministry of Disaster Management and Rehabilitation approves the amount of food grain, usually in a meeting that considers the total allocation from government and the demand from different sectors. It issues an order (at times reducing the total amount), to the Department of Disaster Management's (DDM) Director General, listing the amount of food, number of recipient families, *upazilas* and districts, with a few directives and terms and conditions. The order also directs the DDM to allocate the agreed amount of food to the recipient districts' Deputy Commissioners and to cover transport and other miscellaneous costs. The order is also communicated to the secretary at the office of the Prime Minister; the Ministry of Finance; Ministry of Fisheries and Livestock; the Director General of the Department of Food; and other relevant ministries and departments. **Step 9**. As directed, the DDM Director General allocates the agreed amount of food to the DCs in the recipient districts, requesting that they distribute the food incentives among local, poor eligible fishers (included in the list of affected fishers prepared in the earlier steps) who abstain from *jatka* fishing during the ban period, following the humanitarian aid implementation guidelines of 2012–2013, and maintain records and accounts for auditing. A copy of the order is also communicated to the relevant deputy secretaries of the ministries; Divisional Commissioners; Director General of Supply, Distribution and Marketing of the Ministry of Food; UP chairmen; UNOs; district food controllers; district relief and rehabilitation officers; *upazila* food controllers; and other relevant officials. **Step 10**. The Deputy Commissioner in each district meets with the relevant UNOs to authorise the allocated amount of food. **Step 11**. The UNOs collect their allocation letters and organise a meeting with the relevant UPCs, giving each a copy of the allocation letter to authorise them to collect the food from the local store depot. **Step 12**. The UPCs or secretaries collect the allocation letter and delivery order from the UNO and submit it to the officer in charge of the local store depot. After weighing samples of the food, which are in sealed sacks or bags, they transport it to the UP yard for distribution to fisher households. **Step 13**. The food is brought to the UP yard from the local store depot in sealed sacks containing 80kg of food grain, or polythene bags of 50kg, or both. The UPCs set a date for food distribution, informing beneficiaries via the *chaukidar* (local watchman) or a UP member. The recipient fishers then gather at the UP yard on the scheduled date. The fishers only receive a portion of the amount in the sealed bags, and the UPCs have to cover transport costs by selling the bags afterwards. The bags are opened in the UP yard, and food is weighed by a UP member and distributed under the supervision of a Task Assignment Officer. Occasionally, a representative from the Upazila Fisheries Office remains present for the food distribution. The fishers receive their allotted food grain in their own bag or container, recording the amount on their VGF card.	**Step 6**. On receiving the tenders, the UFO sets out a comparative price list of the materials to procure. The ten-member Upazila Purchase Committee meets with the UFO and selects suppliers from the list. **Step 7**. The UFO issues an order to the successful bidders to supply the materials. **Step 8**. Meanwhile, the UFOs and Jatka Conservation Project officials organise training for the AIGA beneficiaries in each *upazila*. They invite *upazila*-level specialists to deliver lectures or demonstrate practical courses on specific trades. The training costs are covered by the conservation project. **Step 9**. After receiving the AIGA materials, the UFO organises a meeting to ceremonially award them to the beneficiaries in the presence of the UNO, hilsa management officials, UP chairmen and members, and the local elite. The meeting includes a speech on the importance of hilsa management and AIGA, and the benefit of these activities to the fishers as well as to the nation. Each beneficiary supplies a receipt for the materials they have received. **Step 10**. The suppliers of the materials submit their bills to the UFO, who examines, approves and forwards them with a payment order to the Upazila Accounts Office, from where the suppliers receive their payment. **Step 11**. Finally, the UFO sends the detailed list of AIGA beneficiaries and a statement of expenditure, with a copy of the bills and receipts, to the office of the Jatka Conservation Project Director at Dhaka. *reproduced from Haldar and Ali (2014)

REFERENCES

Ahlheim, M. and Neef, A. (2006) Payments for environmental services, tenure security and environmental valuation: concepts and policies towards a better environment. *Quarterly Journal of International Agriculture* 45(4): 303–318.

Ahsan, D.A., Naser, M.N., Bhaumik, U., Hazra, S. and Bhattacharya, S.B. (2014) *Migration, Spawning Patterns and Conservation of Hilsa Shad (Tenualosa ilisha) in Bangladesh and India.* IUCN and Academic Foundation, New Delhi.

Amin, S.M.N., Rahman, M.A., Haldar, G.C., Mazid, M.A. and Milton, D. (2002) Population dynamics and stock assessment of hilsa shad, *Tenualosa ilisha* in Bangladesh. *Asian Fishery Science* 15: 123–128.

Amin, S.M.N., Rahman, M.A., Haldar, G.C., Mazid, M.A. and Milton, D.A. (2008) Catch per unit effort, exploitation level and production of hilsa shad in Bangladesh. *Asian Fishery Science* 21: 175–187.

Asian Development Bank (2004) *Country Environmental Analysis: Bangladesh*. Bangladesh Development Series 12. World Bank, Washington DC.

Azad, A. (2016) Personal communication, 3 March 2016.

Balmford, A. and Whitten, T. (2003) Who should pay for tropical conservation, and how could the costs be met? *Oryx* 37: 238–250.

Begum, F.A. (2015) Ensuring efficient water use in industries. *The Financial Express,* 18th April 2015. See: http://print.thefinancialexpress-bd.com/2015/04/18/89194/print

Berkes, F. (2009) Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management* 90: 1692–1702.

Bladon, A., Mohammed, E.Y. and Milner-Gulland, E.J. (2014) *A Review of Conservation Trust Funds for Sustainable Marine Resources Management. Conditions for Success*. IIED Working Paper. IIED, London. See: http://pubs.iied.org/16574IIED.html

Bladon, A.J. (2016) *Conservation Payments in Data-Poor, Developing-World Fisheries.* PhD thesis, Imperial College London.

Bladon, A.J., Short, K.M., Mohammed, E.Y. and Milner-Gulland, E.J. (2014) Payments for ecosystem services in developing world fisheries. *Fish and Fisheries*, DOI: 10.1111/faf.12095

Campese, J. (2012) *Equitable Benefit Sharing: Exploring Experiences and Lessons for REDD+ in Tanzania*. Tanzania Natural Resource Forum 39.

Carbonetti, B., Pomeroy, R., and Richards, D.L. (2014) Overcoming the lack of political will in small scale fisheries. *Marine Policy* 44: 295–301.

CBD Secretariat (2011) *The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity*. Convention on Biological Diversity, Canada.

Clements, T. and Milner-Gulland, E.J. (2014) Impact of payments for environmental services and protected areas on local livelihoods and forest conservation in northern Cambodia. *Conservation Biology* 29(1): 1–10.

Conservation Finance Alliance (2008) *Rapid Review of Conservation Trust Funds*. Prepared for the CFA Working Group on Environmental Funds by Barry Spergel and Philippe Taïeb.

Constantino, P.D., Carlos, H., Ramalho, E., Rostant, L., Marinelli, C., Teles, D., Fonseca-Junior, S., Fernandes, R. and Valsecchi, J. (2012) Empowering local people through community-based resource monitoring: a comparison of Brazil and Namibia. *Ecology and Society,* 17(4): 22.

Danielsen, F., Balete, D.S., Poulsen, M.K., Enghoff, M., Nozawa, C.M. and Jensen, A.E. (2000) A simple system for monitoring biodiversity in protected areas of a developing country. *Biodiversity and Conservation* 9: 1671–1705.

Danielsen, F., Burgess, N.D. and Balmford, A. (2005) Monitoring matters: examining the potential of locally-based approaches. *Biodiversity and Conservation* 14: 2507–2542.

Danielsen, F., Burgess, N.D., Balmford, A., Donald, P.F., Funder, M., Jones, J.P.G., Alviola, P., Balete, D.S., Blomley, T., Brashares, J., Child, B., Enghoff, M., Fjeldså, J., Holt, S., Hübertz, H., Jensen, A.E., Jensen, P.M., Massao, J., Mendoza, M.M., Ngaga, Y., Poulsen, M.K., Rueda, R., Sam, M., Skielboe, T., Stuart-Hill, G., Topp-Jørgensen, E. and Yonten, D. (2008) Local participation in natural resource monitoring: a characterization of approaches. *Conservation Biology* 23: 31–42.

DoF (2014) Fishery statistical yearbook of Bangladesh. Department of Fisheries, Dhaka, Bangladesh.

Dutta, D. (2009) *Elite Capture and Corruption: Concepts and Definitions.* National Council of Applied Economic Research.

Erg, B., Vasilijević, M. and McKinney, M. (2012) *Initiating Effective Transboundary Conservation: A Practitioner's Guideline Based on the Experience from the Dinaric Arc*. IUCN Programme Office for South-Eastern Europe, Gland, Switzerland and Belgrade, Serbia.

Falke, J.A., Dunham, J.B., Jordan, C.E., McNyset, K.M. and Reeves, G.H. (2013) Spatial ecological processes and local factors predict the distribution and abundance of spawning by steelhead (*Oncorhynchus mykiss*) across a complex riverscape. *PLoS One* 8, e79232.

FAO (2012) *International Guidelines for Securing Sustainable Small-scale Fisheries*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2013) *Implementing Improved Tenure Governance in Fisheries. A Technical Guide to Support the Implementation of the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security*. Food and Agriculture Organization of the United Nations, Rome.

FAO (2014) *The State of World Fisheries and Aquaculture*. Food and Agriculture Organization of the United Nations, Rome.

FFI (2014) *Equitable Benefit Sharing: Lessons Learned from REDD+ and Other Conservation Strategies*. See: http://tinyurl.com/FFI-2014-benefit-sharing

Freyhof, J. (2014) *Tenualosa ilisha*. IUCN Red List of Threatened Species 2014. See: http://dx.doi.org/10.2305/IUCN.UK.2014-1.RLTS.T166442A1132697.en

FRSS (2013) *Fisheries Statistical Yearbook of Bangladesh 2011–2012*. Fisheries Resources Survey System, Department of Fisheries, Bangladesh. Volume 29: 44.

FRSS (2014) *Fisheries Statistical Yearbook of Bangladesh 2012–2013*. Fisheries Resources Survey System Department of Fisheries, Bangladesh. Volume 30: 52.

GEF (1998) *Evaluation of Experience With Conservation Trust Funds.* Global Environment Facility Secretariat. See: www.cbd.int/financial/trustfunds/g-gefevaluation.pdf

Greiber, T. (2009) *Payments for Ecosystem Services. Legal and Institutional Frameworks*. IUCN Environmental Policy and Law Paper. IUCN, Gland, Switzerland.

Grüss, A., Robinson, J., Heppell, S.S., Heppell, S.A. and Semmens, B.X. (2014) Conservation and fisheries effects of spawning aggregation marine protected areas: what we know, where we should go, and what we need to get there. *ICES Journal of Marine Science* doi:10.1093/icesjms/fsu038

Haldar, G.C. and Ali, L. (2014) *The Cost of Compensation: Transaction and Administration Costs of Hilsa Management in Bangladesh*. IIED Working Paper, London. See: http://pubs.iied.org/15522IIED.html

Hamilton, R.J., Giningele, M., Aswani, S. and Ecochard, J.L. (2012) Fishing in the dark – local knowledge, night spearfishing and spawning aggregations in the Western Solomon Islands. *Biological Conservation* 145: 246–257.

Harley, C. and Rogers-Bennett, L. (2004) The potential synergistic effects of climate change and fishing pressure on exploited invertebrates on rocky intertidal shores. *California Cooperative Oceanic Fisheries Investigation Reports* 45: 98–110.

Hasan, K.M.M., Wahab, M.A., Ahmed, Z.F. and Mohammed, E.Y. (2015) *The Biophysical Assessments of the Hilsa Fish (Tenualosa Ilisha) Habitat in the Lower Meghna, Bangladesh*. London. IIED Working Paper, London. See: http://pubs.iied.org/16605IIED.html

Hasan, K.M.M., Ahmed, Z.F., Wahab, M.A. and Mohammed, E.Y. (in prep) Reproductive seasonality of hilsa shad, *Tenualosa ilisha* (Hamilton 1822) in the River Meghna, Bangladesh.

Hein, L., Miller, D.C. and de Groot, R. (2013) Payments for ecosystem services and the financing of global biodiversity conservation. *Current Opinions in Environmental Sustainability* 5: 87–93.

Holck, M.H. (2008) Participatory forest monitoring: an assessment of the accuracy of simple cost-effective methods. *Biodiversity and Conservation* 17: 2023–2036.

Islam, M., Mohammed, E.Y. and Ali, L. (2016) Economic incentives for sustainable hilsa fish management in Bangladesh: an analysis of the legal and institutional framework. *Marine Policy* 68: 8–22. See: http://pubs.iied.org/G04022.html

Johnson, N., Ravnborg, H.M., Westermann, O. and Probst, K. (2001) *User Participation in Watershed Management and Research.* CAPRi Working Paper No. 19, International Food Policy Research Institute (IFPRI), Washington, DC.

Kanagawa, M. and Nakata, T. (2007) Analysis of the energy access improvement and its socio-economic impacts in rural areas of developing countries. *Ecological Economics* 62: 319–329.

Karvonen, A., Rintamäki, P., Jokela, J. and Valtonen, E.T. (2010) Increasing water temperature and disease risks in aquatic systems: climate change increases the risk of some, but not all, diseases. *International Journal for Parasitology* 40(13): 1,483–1,488.

Keane, A., Jones, J.P.G., Edwards-Jones, G. and Milner-Gulland, E.J. (2008) The sleeping policeman: understanding issues of enforcement and compliance in conservation. *Animal Conservation* 11: 75–82.

Khan, M.S., Ahmed, S., Evans, A.E.V. and Chadwick, M. (2009) Methodology for performance analysis of textile effluent treatment plants in Bangladesh. *Chemical Engineering Research Bulletin* 13: 61–66.

Kooiman, J. and Jentoft, S. (2009) Meta-governance: values, norms and principles, and the making of hard choices. *Public Administration* 87: 818–836.

Larson, A. and Ribot, J. (2004) Democratic decentralisation through a natural resource lens: an introduction. *European Journal of Development Research* 16: 1–25.

Lele, U. (2010) Food security for a billion poor. *Science* 327: 1,554.

Lozano-Montes, H.M., Pitcher, T.J. and Haggan, N. (2008) Shifting environmental and cognitive baselines in the upper Gulf of California. *Frontiers in Ecology and the Environment* 6: 75–80.

Luttrell, C., Loft, L., Gebara, M.F., Kweka, D., Brockhaus, M. and Angelsen, A. (2013) Who should benefit from REDD + ? Rationales and realities. *Ecology and Society* 18: 52.

Majumder, M.K., Hossain, M.M., Ahmed, C.S., Ali, M.L. and Mohammed, E.Y. (2015a) *Hilsa Conservation Foundation. Background Document.* Bangladesh Centre for Advanced Studies (BCAS), Dhaka and International Institute for Environment and Development (IIED), London.

Majumder, M.K., Hossain, M.M., Ahmed, C.S., Ali, M.L. and Mohammed, E.Y. (2015b) *Memorandum and Articles of Association. Hilsa Conservation Foundation*. International Institute for Environment and Development (IIED), London.

Miah, M. S. (2015) Climatic and anthropogenic factors changing spawning pattern and production zone of Hilsa fishery in the Bay of Bengal. *Weather and Climate Extremes* 7: 109–115.

Miranda, M., Porras, I.T. and Moreno, M.L. (2003) *The Social Impacts of Payments for Environmental Services in Costa Rica: A Quantative Field Survey and Analysis of the Virilla Watershed*. International Institute for Environment and Development (IIED), London. See: http://tinyurl.com/miranda-et-al-2003

Mohammed, E.Y. (2011) *Pro-Poor Benefit Distribution in REDD +: Who Gets What and Why Does It Matter*? REDD Working Paper. International Institute for Environment and Development (IIED), London. See: http://pubs.iied.org/16508IIED.html

Mohammed, E.Y. (2012) *Payments for Coastal and Marine Ecosystem Services: Prospects and Principles*. IIED Briefing. International Institute for Environment and Development (IIED), London. See: http://pubs.iied.org/17132IIED.html

Mohammed, E.Y. (2013) *Incentive-based Hilsa Fish Conservation and Management in Bangladesh: Prospects and Challenges.* IIED Workshop Report. International Institute for Environment and Development (IIED), London.

Mohammed, E.Y., Ahmed, C.S. and Ali, M.L. (2014) *Mitigating Unintended Local Economic Impacts of the Compensation Scheme for Hilsa Management*. IIED Briefing. International Institute for Environment and Development (IIED), London. See: http://pubs.iied.org/17282IIED.html

Mohammed, E.Y. and Brouwer, R. (unpublished) *Assessing Preferences for Compensation Packages using the Choice Experiment Method: The Case Of Hilsa (Tenualosa Ilisha) Management in Bangladesh.*

Mohammed, E.Y., Porras, I., Grieg-Gran, M., Lima, L., Soares, A., Neto, J.T. and Viana, V. (2013) Assessing preferences for compensation packages using the discrete choice method: the case of the Bolsa Floresta Program in Amazonas, Brazil. *Journal of Environmental Assessment Policy and Management* 15: 20.

Mohammed, E.Y. and Wahab, M.A. (2013) *Direct Economic Incentives for Sustainable Fisheries Management: The Case Of Hilsa Conservation in Bangladesh*. International Institute for Environment and Development, London. See: http://pubs.iied.org/16527IIED.html

Mome, M.A. (2007) *The Potential of the Artisanal Hilsa Fishery in Bangladesh: An Economically Efficient Fisheries Policy*. The United Nations University, Fisheries Training Programme. See: www.unuftp.is/static/fellows/document/masud07prf.pdf

Moore, J.E., Cox, T.M., Lewison, R.L., Read, A.J., Bjorkland, R., McDonald, S.L., Crowder, L.B., Aruna, E., Ayissi, I. and Espeut, P. (2010) An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. *Biological Conservation* 143: 795–805.

Nielsen, J.R. (2003) An analytical framework for studying compliance and legitimacy in fisheries management. *Marine Policy* 27: 425–432.

NOAA (2014) *Gillnets: Fishing Gear and Risks to Protected Species*. See: www.nmfs.noaa.gov/pr/interactions/gear/gillnet.htm

Nuno, A., Bunnefeld, N., Naiman, L.C. and Milner-Gulland, E.J. (2013) A novel approach to assessing the prevalence and drivers of illegal bushmeat hunting in the Serengeti. *Conservation Biology* 27: 1,355–1,365.

Nuno, A. and St John, F.A.V. (2014) How to ask sensitive questions in conservation: a review of specialized questioning techniques. *Biological Conservation* 189: 5–15.

Pascual, U., Muradian, R., Rodríguez, L.C. and Duraiappah, A. (2010) Exploring the links between equity and efficiency in payments for environmental services: a conceptual approach. *Ecological Economics* 69: 1,237–1,244.

Pauly, D. (2006) Major trends in small-scale fisheries, with emphasis on developing countries, and some implications for the social sciences. *MAST* 4: 7–22.

Pham, T.T., Campbell, B.M. and Garnett, S. (2009) Lessons for pro-poor payments for environmental services: an analysis of projects in Vietnam. *Asia Pacific Journal of Public Administration* 31: 117–133.

Pomeroy, R.S. (2001) Devolution and fisheries co-management. In: *Collective Action, Property Rights and Devolution of Natural Resource Management – Exchange of Knowledge and Implications for Policy*. Zentralstelle fur Ernahrung und Landwirtschaft, Feldafing, Germany.

Pomeroy, R.S., Katon, B.M. and Harkes, I. (2001) Fisheries co-management: key conditions and principles drawn from Asian experiences. *Marine Policy* 25: 197–208.

Pomeroy, R.S. and Rivera-Guieb, R. (2006) *Fishery Co-Management: A Practical Handbook*. CABI Publishing, International Development Rseearch Centre (IDRC).

Rahman, M. and Naevdal, G. (2000) Population genetic studies of hilsa shad, *Tenualosa ilisha* (Hamilton), in Bangladesh waters: evidence for the existence of separate gene pools. *Fisheries Management and Ecology* 7: 401–411.

Rahman, M.J., Rahman, M.A. and Bhaumik, U. (2012) Biology and ecology of hilsa shad, *Tenualosa ilisha* (Ham.) In: *Hilsa: Status of Fishery and Potential for Aquaculture*. Proceedings of the Regional Workshop Held in Dhaka, 16–17 September 2012. The WorldFish, Bangladesh and South Asia Office, Dhaka: 1–39.

Rahman, M., Rahman, B., Hasan, S., Flura, Ahmed, T. and Haidar, M. (2013) Impact of eleven days fishing ban in the major spawning grounds of hilsa (*Tenualosa ilisha*) on its breeding success. *Bangladesh Research Publications Journal* 9: 116–122.

Roux, D.J., Ashton, P.J., Nel, J.L. and MacKay, H.M. (2008) Improving cross-sector policy integration and cooperation in support of freshwater conservation. *Conservation Biology* 22: 1,382–1,387.

Scott, G.R. and Sloman, K.A. (2004) The effects of environmental pollutants on complex fish behaviour: integrating behavioural and physiological indicators of toxicity. *Aquatic Toxicology* 68(4): 369–392.

Sharma, A.P., Naskar, M., Joshi, K.D., Bhattacharjya, B.K., Sahu, S.K., Das, S., Sudheesan, D., Srivastava, P.K., Rej, A. and Das, M.K. (2014) *Impact of Climate Variation on Breeding of Major Fish Species in Inland Waters*. Central Inland Fisheries Research Institute, Kokata, West Bengal. Bulletin 185: 32.

Sinha, R. K. and Ahmed, B. (eds.) (2014). Rivers for Life - Proceedings of the International Symposium on River Biodiversity: Ganges-Brahmaputra-Meghna River System, Ecosystems for Life, A Bangladesh-India Initiative, IUCN, International Union for Conservation of Nature, 340 pp.

St John, F.A., Edwards-Jones, G., Gibbons, J. and Jones, J.P. (2010) Testing novel methods for assessing rule breaking in conservation. *Biological Conservation* 143: 1,025–1,030.

Thompson, P.M., Sultana, P. and Islam, N. (2003) Lessons from community based management of floodplain fisheries in Bangladesh. *Journal of Environmental Management* 69: 307–321.

Ticheler, Kolding, Chanda (1998) Participation of local fishermen in scientific fisheries data collection: a case study from the Bangweulu Swamps, Zambia. *Fisheries Management and Ecology* 5: 81–92.

Trimble, M. and Berkes, F. (2013) Participatory research towards co-management: lessons from artisanal fisheries in coastal Uruguay. *Journal of Environmental Management* 128: 768–778.

Ullah, H., Gibson, D., Knip, D., Zylich, K. and Zeller, D. (2014) *Reconstruction of Total Marine Fisheries Catches for Bangladesh: 1950–2010*. Working Paper Series. University of British Columbia. See: www.seaaroundus.org/doc/publications/wp/2014/Ullah-et-al-Bangladesh.pdf

Uraguchi, Z. B. and Mohammed, E.Y. (2016) Harnessing market forces for financial inclusion in marine and coastal conservation: lessons from market systems development approach. In Mackelworth, P. (Ed.) *Marine Transboundary Conservation and Protected Areas*. Routledge Earthscan.

Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A.A., Watson, R. and Zeller, D. (2009) Rebuilding global fisheries. *Science* 325: 578–585.

Wright, J.H., Hill, N.A., Roe, D., Rowcliffe, J.M., Kümpel, N.F., Day, M., Booker, F. and Milner-Gulland, E.J. (2016) Reframing the concept of alternative livelihoods. *Conservation Biology* 30(1): 7–13.

Wu, R.S.S., Zhou, B.S., Randall, D.J., Woo, N.Y.S. and Lam, P.K.S. (2003) Aquatic hypoxia is an endocrine disruptor and impairs fish reproduction. *Environmental Science & Technology* 37(6): 1,137–1,141.

Wunder, S. (2007) The efficiency of payments for environmental services in tropical conservation. *Conservation Biology* 21: 48–58.

Wunder, S. (2005) *Payments for Environmental Services: Some Nuts and Bolts*. CIFOR Occasional Paper 42. See: www.cifor.org/publications/pdf_files/OccPapers/OP-42.pdf

Wunder, S. and Albán, M. (2008) Decentralised payments for environmental services: the cases of Pimamppio and PROFAFOR in Ecuador. *Ecologial Economics* 65(4): 685–698.

Yoccoz, N., Nichols, J. and Boulinier, T. (2001) Monitoring of biological diversity in space and time. *Trends in Ecology and Evolution* 16: 446–453.

BALANCING CARROTS AND STICKS

INCENTIVES FOR SUSTAINABLE HILSA FISHERY MANAGEMENT IN BANGLADESH

Fisheries play an important role in meeting global food demands. But coastal fisheries are in decline due to overfishing – and fisheries management in developing world countries is also complicated by significant poverty levels. In response, fisheries managers are increasingly using economic incentive-based approaches to reward beneficiaries – such as fishers – for complying with legislation aimed at sustainably managing the resource.

One of the rare examples of both mismanagement and restoration of fisheries using an economic-incentive mechanism is Bangladesh's most important single-species fishery: hilsa. In 2004, a scheme was developed to support hilsa management in Bangladesh. But inadequacies were identified with the regulatory framework and the compensation scheme. This synthesis report is the outcome of a Darwin Initiative-funded project which has sought to improve the effectiveness of the incentive-based hilsa management scheme. It assesses the current ecological and socio-economic dynamics of hilsa fishery management in Bangladesh. The outcomes and recommendations should be of much use in hilsa fisheries management and improving the livelihoods of fishing communities.

iied

The International Institute for Environment and Development is one of the world's top policy research organisations working in the field of sustainable development. With its broadbased network of partners, IIED is helping to tackle the biggest issues of our times – from climate change and cities to the pressures on natural resources and the forces shaping global markets.

International Institute for Environment and Development
80–86 Gray's Inn Road
London, England
WC1X 8NH
Tel: +44 (0)20 3463 7399
Fax: +44 (0)20 3514 9055
email: info@iied.org
www.iied.org