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The Festschrift on the 50th Anniversary of
The IUCN Red List of Threatened Species™

Compilation of Papers and Abstracts

Updating Species Red List of Bangladesh

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The *Festschrift* on the 50th Anniversary of The IUCN Red List of Threatened Species™

Compilation of Papers and Abstracts

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The German word Festschrift has been incorporated into the English language to describe a volume of writings by academicians/scholars collected in honor of somebody/something that has contributed remarkably in enriching human knowledge.

Preface

The IUCN Red List is the starting point for conservation! 2014 marks the 50th anniversary of the IUCN Red List. The IUCN Red List of Threatened Species™ has been assessing the conservation status of plants, fungi and animal species on a global scale for the past 50 years. Since its conception in 1964, the Red List has evolved to become the world's most comprehensive information source on the extinction risk of animal, fungi and plant species. Far more than a list of species and their status, it is a powerful tool to inform and catalyze action among scientists, activists, and politicians. It is used by government agencies, wildlife departments, conservation-related non-governmental organizations (NGOs), natural resource planners, educational organizations, students, and the business community. The Red List process has become a massive enterprise involving the IUCN Global Species Program staff, partner organizations and experts in the IUCN Species Survival Commission and partner networks who compile the species information to make The IUCN Red List the indispensable product it is today.

IUCN Bangladesh had published the first Red List of Threatened Animals of Bangladesh in 2000. The list is being updated since December 2013 through a sub-project titled "Updating Species Red List of Bangladesh" under the "Strengthening Regional Cooperation for Wildlife Protection Project" (SRCWP) of the Bangladesh Forest Department which is funded by World Bank.

As part of the IUCN Red List's 50th anniversary campaign, Red List 50, IUCN Bangladesh Country Office organized a day-long programme on 22 December 2014 at the Bangabandhu International Convention Center (BICC). The programme includes two technical sessions which participated by scientists, wildlife biologists, nature lovers, conservationists, students, media, policy makers, development partners, etc. The technical sessions highlighted research papers carried out by the individuals/institutions to uphold their contribution to enrich the knowledge of wildlife of Bangladesh in a wider context. This manuscript entitled "The Festschrift on the 50th Anniversary of The IUCN Red List of Threatened SpeciesTM" to commemorate this occasion contains keynote papers, full papers and abstracts that presented during the sessions of the programme. This is a first of its kind of volume that compiled a wide range of research done in Bangladesh on wildlife diversity, conservation biology and policy.

I would like to commend the authors for their contributions to the manuscript and for their commitment towards making this a reality. The papers have been reviewed by a panel of experts and have been revised and edited as per suggestions of the reviewers. The tireless efforts of the reviewers in making the papers up to the standard are gratefully acknowledged. Without their assistance this manuscript would not have been of the quality that it is now.

I like to take this opportunity to express my sincere appreciation to all the members of Updating Species Red List of Bangladesh Project and all concerned people of publication work for publishing this manuscript to mark the 50th anniversary of the IUCN Red List. I would also express my gratitude to Ministry of Environment & Forest (MoEF), Chief Conservator of Forest (CCF) and other Forest Department officials for their vigorous support and collaboration. I hope this manuscript will help current researchers in finding historical research papers/abstracts in a one cover of volume in future.

Dhaka
December 2014

Ishtiaq Uddin Ahmad
Country Representative
IUCN Bangladesh

Note From The Publication Committee

We would like to thank our authors for their excellent response! We received a total of 121 abstracts , of which our panel of editors primarily selected 75. The panel finally selected 21 full papers for publication. We have also selected more 50 abstracts for poster presentation during the workshop day guided by our editorial panel. Authors sent their final papers after incorporating their responses to the comments made by the panel. The papers received for the programme have been finally arranged in this book according to the presentation schedule of the technical sessions.

The papers have been reproduced directly from the authors' original soft copy of the manuscripts while quickly checking for the most obvious typographical errors. We tried to reformat and edit to comply with the prescribed page limit and article preparation guideline. We hope that any error that may be still be present on the proceedings which will not distract the readers.

The Publication Committee is not responsible for the views, statements and opinions of the authors in their papers included in the proceedings.

Mohammad Shahad Mahabub Chowdhury
Head, Publication Committee

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About IUCN

IUCN, International Union for Conservation of Nature, helps the world find pragmatic solutions to our most pressing environment and development challenges.

IUCN works on biodiversity, climate change, energy, human livelihoods and greening the world economy by supporting scientific research, managing field projects all over the world, and bringing governments, NGOs, the UN and companies together to develop policy, laws and best practice.

IUCN is the world's oldest and largest global environmental organization, with more than 1,200 government and NGO members and almost 11,000 volunteer experts in some 160 countries. IUCN's work is supported by over 1,000 staff in 45 offices and hundreds of partners in public, NGO and private sectors around the world.

www.iucn.org

Bangladesh Country Office

IUCN has been working in Bangladesh for over four decades, starting in 1972 when the Government of Bangladesh became a state Member. A fully operational Country Office was established in 1992.

There are currently 17 Members from Bangladesh: the Government of Bangladesh, which is represented by the Ministry of Environment and Forests and 16 non-government organizations.

IUCN Bangladesh works with a variety of stakeholders at the international, national and local levels, including the lowest administrative tiers. It currently has projects focused on co-management of protected areas, adaptation to climate change and variability, community based disaster risk reduction, conservation of flagship species, revival of local governance structures and promotion of dialogue and research of water issues.

The Country Office also provides technical support to the Government of Bangladesh on the implementation and compliance of international conservations and preparation of key national documents, such as the Bangladesh Climate Change Strategy and Action Plan 2009 and Climate Change & Gender Action Plan 2013. It also strives to provide strategic guidance to the private sector to shift to a 'greener' economy and reduce its ecological footprint. IUCN is a source of credible and trusted scientific information. Over the years, it has created a niche role in pilot-scale action research, and publication of approach books and studies.
www.iucn.org/bangladesh

Updating Species Red List of Bangladesh Project

Context

The IUCN Red List of Threatened Species™ is widely recognized as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species and their links to livelihoods. Particularly its scientifically rigorous approach to determine risks of extinction of species has become a world standard.

Looking back at 50 years since its implementation in 1964, the IUCN Red List of Threatened Species™ has been successfully established as a powerful conservation tool playing today a prominent and crucial role in guiding global, regional and national conservation actions, activities and policy decisions of governments, NGOs and scientific institutions.

In order to ensure high profile, standards and scientific integrity of the IUCN Red List of Threatened Species™ the assessment and regular updating process is clear, transparent, well document and supported by the best scientific information available.

Updating Species Red List of Bangladesh

As part of the Bangladesh Forest Department component on "Strengthening Regional Cooperation for Wildlife Protection Project" funded by the World Bank, IUCN aims to update the Red List of Threatened Species for Bangladesh over the course of 2014/2015.

This current updating process is of significant importance due to the facts that it 1) will fill the existing 13 years' assessment gap for bird, fish, mammal, amphibian and reptile species in Bangladesh and their conservation status, 2) adjust the Red List taking into account the global change in IUCN Red List assessment criteria in 2003, 3) will extended the Species Red List of Bangladesh by two important animal groups (Crustacean, Butterflies), 4) will include several newly discovered species which are not listed yet, and 5) will enable the relevant govt. agencies to better monitor the status of a representative selection of species that cover all the major ecosystems of the country. Coinciding with the global 50 years anniversary of the IUCN Red List, the update in Bangladesh will contribute to the celebration of this event and further highlights its significance.

During the 30 months assessment process, members of the IUCN Global Species Programme, the IUCN Survival Commission, IUCN Bangladesh, the Bangladesh Forest Department officials, scientists, conservationists, species specialists and partner organizations will closely work together to ensure most accurate information and analysis of the most current status, trends and threats to wildlife species in Bangladesh.

Altogether seven groups of wildlife species (Mammals, Reptiles, Amphibians, Birds, Freshwater Fishes, Crustacean and Butterflies), encompassing approximately 1700 species, will be assessed or reassessed and their current status analyzed and determined, following the most recent IUCN assessment criteria and guidelines. For this purpose a national committee of 17 members as well as 7 Red List Assessment Groups (RAG), lead by species specialists, have been formed. A series of workshops and trainings will be held to build up skills and ensure a sound and consistent assessment progress.

The expected outcomes of the 2014/2015 Species Red list update for Bangladesh are:

- The current conservation status of all targeted species is evaluated and published in Red List Books.
- Species Red Lists for Butterflies and Crustacean have been developed as a baseline.
- Particularly wildlife species at the risk of extinction have been identified and that information has been communicated and published.
- Capacities of country professionals on assessing and updating species statuses have been built up.

As Lead Assessors for the 7 animal groups headed by Dr. Mohammad Ali Reza Khan have been assigned

- Mammals: Prof. DR. M. Mostafa Feeroz
- Birds: Mr. Enam Ul Haque
- Reptiles: Prof. Dr. Farid Ahsan
- Amphibians: Dr. M. Monirul H. Khan
- Freshwater Fish: Prof. Dr. Mohammad Shahadat Ali
- Crustacean: Prof. Dr. Mostafa A R Hossain
- Butterflies: Prof. Dr. Monwar Hossain

Theme 1: Key Note and Papers

Wildlife Diversity in Bangladesh:
40 Years of Research and Conservation

Key Note

Wildlife diversity in Bangladesh: 40 Years of Research and Conservation

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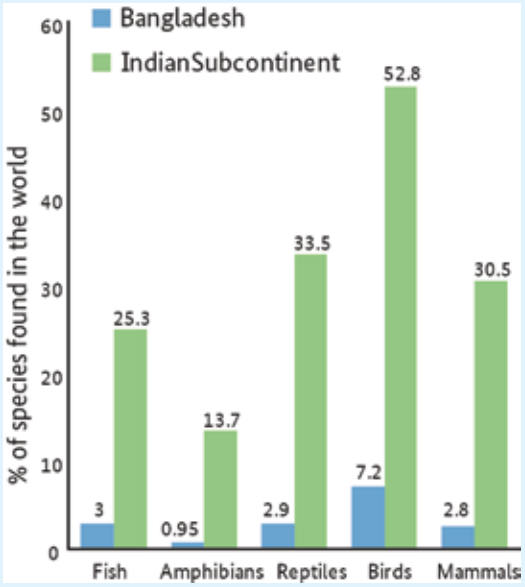
Introduction

In a country like Bangladesh where poverty engulfs everything, wildlife research is treated as a luxury and was not even recognized by policy makers before the 90's. Though the Wildlife Act was formulated in 1974, awareness and implementation of this law was rarely observed prior to our government signing on to the first Earth Summit in 1992. Despite these challenges, Wildlife Research in Bangladesh began well before the independence of our country and was lead by the Professor Kazi Zaker Husain. Though it wasn't until, after independence, in 1974, that the first scientific paper on the wildlife of Bangladesh was published by Dr. Ali Reza Khan (Khan 1974). However, during the last four decades our commitment to wildlife research has grown exponentially and reaches international standards, extending from behavior and ecology to population genetics and transmissible diseases.

From the zoo-geographical point of view Bangladesh is at the junction of the Indo-Himalays and Indo-China sub-regions, one of the few countries where the species of two bio-geographic realms overlap. Because of its geographic location at the eastern end of the Indian subcontinent, Bangladesh is a transitional zone for the flora and fauna of the subcontinent and that of southeast Asia (Stanford 1991). Three migratory fly routes pass over the country, resulting in a stopover haven for the migratory birds during their winter migration (Feeroz 2014). The country, though only 1,47,570 sq km, holds both fertile alluvial land and hilly areas and its warm and humid climate forms diverse ecosystems which support tremendous biodiversity. This natural ecological and biological heritage was recognized by Professor Kazi Zaker Hossain who embarked on wildlife research despite many obstacles.

Biodiversity of Bangladesh

Bangladesh is home to 1952 species of invertebrates, including 300 species of Protozoa , 300 Platyhelminthes, Nematodes and Acanthocephala, 479 Mollusks, 185 Crustaceans and 667 Insects. Among vertebrates, 653 fish species are recorded (accounting for an astonishing 3% of the world's total fish species). Two hundred and fifty-one of these are freshwater fishes and 402 are estuarine and marine fin fishes including sharks and rays. Forty-nine species of amphibians and 154 species of reptiles (including 19 species that are found in our rich marine environments) are recorded in Bangladesh. The number of amphibians characterized in Bangladesh is likely to increase as fieldwork has recently documented another 22 amphibians and 27 reptiles. (Hasan et al. 2014). A total of 706 bird species recorded in Bangladesh represent 7.2% of the world's total species. Three hundred and eighty three resident species , 218 winter visitors, 11 summer visitors and 94 vagrants. Our mammal diversity on land and in the water is equally rich with 128 species (2.8% of the world's total species) found in Bangladesh of which 7 are marine mammals (Khan 2014). Historically, our wildlife diversity was even greater, but 13 species have become extinct from Bangladesh over the last century. Many more are on the brink of extinction. It is estimated that 23% of vertebrates found in Bangladesh are facing different level of threats and the threat is increasing exponentially with rapid habitat destruction. The situation is even more grim for the 57% of reptiles and 36% of mammals which are facing different level of threats in our country (IUCN 2000).



Species diversity in Bangladesh and Indian Subcontinent (Feeroz 2014)

Wildlife Habitats of Bangladesh

On the basis of both biotic and abiotic components of ecosystems, the world is divided into 5 Global Ecological Domains and 20 Global Ecological Zones (FAO 2001). Bangladesh belongs to two of these zones viz. Tropical rain forest GEZ (33%) and Tropical moist deciduous forest GEZ (67%) of the Tropical Domains of Global Ecological Domains. The central, northeastern and southeastern forests belong to Tropical rainforest GEZ (NFA 2007). Because of the variation in temperature, rainfall, soil and hydrological conditions twenty-five bio-ecological zones with distinct characteristics are recognized as major ecosystems in the country (Nishat et al. 2002). The country has 1.45 million hectares of forest land (9.8% of total area), including 1.21 million ha (84%) natural forest and 0.24 million ha (16%) plantations (NFA 2007).

On the basis of the vegetation characteristics natural forests are of three kinds, viz., evergreen/semi-evergreen, deciduous and mangrove forest. Non continuous freshwater swamp is distributed in the basin of the northeast region. Tropical evergreen and semi evergreen forest are extended over Chittagong, Chittagong Hill Tracts, Cox's Bazar (in the southeast) and Sylhet (in the northeast) covering an area of 6,700km^2 which is 4.54% of total landmass of the country and 44% of natural forest land. Dominant plant species are *Dipterocarpus spp., Artocarpus spp., Ficus spp., Sapium baccatum, Syzygium spp., Prunus ceylanica, Mangifera spp., Tectona grandis* etc. The Madhupur Tract (in the central part of the country) is the largest single mass of moist deciduous sal forest in Bangladesh, with an area of 340 sq km (NFA 2007). Dominant plants of this forest are *Shorea robusta, Dillenia pentagyna, Lagerstroemia speciosa, Adina cordifolia, Albizia spp., Terminalia spp., Spatholobus roxburghii, Entada pursaetha*. The Sundarbans is a mangrove forest, located at the southern extremity of the rivers Padma (Ganges) and Jamuna (Brahmaputra) delta covering an area of about 5770 sq km (Hussain and Acharya 1994). Generally this forest includes fairly dense evergreen plant species of about 10-15m height, which are adapted for life under saline conditions and frequent inundation by the tides. The Sundarbans trees have succulent leaves, stilt roots, pneumatophores and seeds germinate while still on the parent plant. Common plant species are *Heritiera fomes, Exocaria agallocha, Sonneratia spp., Nypa fruticans, Rhizophora spp., Phoenix paludosa, Ceriops spp., Acanthus ilicifolius, Acrostichus aureum*. Wetlands of Bangladesh also support a large number of wild animals of the country. Nearly 50% (eight million hectares) of the total land surface of the country are considered as wetland which includes rivers, natural lakes, freshwater marshes, baors (oxbow lakes), beels (floodplain depressions), ponds, tanks, one large reservoir (Kaptai lake), estuarine areas, mangrove forests and extensive seasonally inundated floodplains.

Protected Areas of Bangladesh

As a part of the Indian subcontinent, Bangladesh has a long history of non-formal forest management, going back to 252 B.C. when the Emperor Asoka of India passed an edict for the protection of animals, fish and forests. This may be the earliest documented case of the deliberate establishment of what we call Protected Areas (PAs) today. During the Mughal Era, the Mughal Emperor and the local rulers preserved some forest areas as hunting grounds for the elite group.

Forests were brought under the government's jurisdiction and parts of the forests were declared as Reserves where logging was not permitted during the British Colonial Era. In 1793, the Government of British India officially took control of the forests and in 1865 the Forest Department was created and the first Forest Act was promulgated (Khan 2008). The existing Sundarbans was notified and declared as "Reserved Forest" during 1875-76. The existing 'Reserved Forests' in the greater Sylhet district were declared under a similar Act, "Assam Forest Regulation" during the British rule while the forests of Chittagong and Chittagong Hill Tracts were also declared "Reserved Forests" in early 20th century during the British rule. The first declaration of Protected Areas was under the provision of the Forest Act 1927 and Modhupur National Park was the first PA established in 1962 and extended in 1982.

Legal status of the PAs improved considerably after the independence of Bangladesh through the formulation and implementation of Bangladesh Wildlife Act in 1974 and several new Protected Areas were declared after the signing of Rio Convention in 1992 (United Nations Conference on Environment and Development, also known as the Rio Summit or Earth Summit). According to Wildlife Act 1974, there are three types of clearly defined Protected Areas: National Park, Wildlife Sanctuary and Game Reserve which eventually corresponded with the IUCN categories II, IV and VI respectively (IUCN 1994). Article 23 of the Wildlife Act 1974 has provisions for declaration of Protected Areas and also has regulations prohibiting certain activities in the Protected Areas. In 2012 the Government formulated a new set of laws for the protection of wildlife in the country and these were adopted by the parliament as the Wildlife (Protection and Safety) Act 2012. The law contains a wide ranging definition of wildlife and forest related offences and crimes. Protected Areas are elaborately expanded in this Act to include 10 new types of areas for the conservation and safety of wildlife. Chapter 4 of Wildlife Act of 2012 states that an area designated as area a Wildlife Sanctuary, National Park, Community Conserved Area, Safari Park, Eco Park, Botanical Garden, Wildlife Breeding Center, Special Biodiversity Protected Area, Landscape Zone, Corridor, Buffer Zone or Core Zone can be declared Protected Area.

At present 17 National Parks and 20 Wildlife Sanctuaries are located throughout the country, including the country's only Game Reserve "Teknaf Game Reserve" which was established in 1983 then converted to Wildlife Sanctuary in 2010. In addition to these 37 PAs, two Botanical Gardens (Baldha Garden and National Botanical Garden in Dhaka), one Safari Park (Dulahazra SP at Cox's Bazar) and seven Eco Parks were established and are managed by the Forest Department and are now covered under Wildlife Act 2012. These garden and eco-park conservation sites are mostly used for recreational purposes. However, these unprotected areas also support a considerable wildlife diversity of the country. All these PAs are under Forest Department's jurisdiction.

Together, these PAs cover 10.7% of the forest areas, and 5.9% of the total area of Bangladesh. Unfortunately, this represents the second lowest per capita area under protection of any country of the world (Sharma et al. 2005). Increased population pressure with its demand for fuel wood is wiping out the vegetal cover and forests of our country. Rampant urban development throughout Bangladesh's forested areas as well as the conversion of wildlife habitats into human settlements has resulted in an unprecedented threat to the biodiversity of the country.

Since the Forest Department is responsible for the protection of wildlife only in and around the PAs (which are within the forests and under FD jurisdiction), other important wildlife habitats which have no legal status as PAs are being destroyed or used for other purposes. With the growing need for protecting wildlife in other important habitats outside forests, new approaches are essential. Considering this scenario, the government has declared under the Section 5 of The Bangladesh Environment Conservation Act, 1995 some spots located outside of forests as Ecologically Critical Areas (ECAs) for the protection of biodiversity in its natural environment and sustainable environmental management. The Director General of the Department of Environment may use this Act to declare ECAs in situations where the ecosystem is considered to be threatened or near a critical state. The government may establish ECAs if 1) the ecosystem of any area has reached, or is likely to reach a critical state by notification in the official Gazette, such area to be an Ecologically Critical Area; or 2), in the notification issued under sub-section (1) or by separate notification, determine the operations or processes which shall not be continued or commenced in the Ecologically Critical Area. In 1999, several areas of Bangladesh were declared 'Ecologically Critical Areas' (ECAs) which are in fact administrated by the Department of Environment (DoE), not the Forest Department. All activities that may further deteriorate the environment are prohibited in these areas.

Three wildlife sanctuaries of the Sundarbans (East, West and South), along with surrounding areas of about 1400sq km, are designated as "World Heritage Site" by UNESCO in 1997. Additionally, the Sundarbans, along with Tangua Haor, has also become designated as RAMSAR (define this acronym) sites of international importance to preserve the ecosystems and to provide facilities for research, education and recreation.

Research

Prior to Independence wildlife research conducted in Bangladesh was cited as part of British India. However, systematic research on wildlife of Bangladesh was started by Professor Kazi Zaker Husain before our independence and first research article on wildlife of Bangladesh was published by Dr. Ali Reza Khan in the inaugural issue of the Bangladesh Journal of Zoology in 1974. Over the last 40 years more than 500 research articles have been published on different aspects of wildlife ecology, behavior, management and conservation of Bangladesh in national and international journals.

Academic research on the wildlife of Bangladesh has primarily been conducted by the faculty and students at the University of Dhaka, Chittagong University and Jahangirnagar University. These institutions all possess wildlife research laboratories and facilities. However, additional conservation work on the wildlife of Bangladesh has been conducted by other organization including IUCN-Bangladesh, Arannayk Foundation, Bangladesh Forest Department and some NGOs.

Prior to 1990's most of the wildlife research in our country was focused on surveying animals in different regions. Generally, these studies focused on species diversity rather than population density. Some ecological work was also undertaken done and provided basic behavioural ecology on some critically endangered species of our country. These early studies highlighted our country's wildlife diversity and generated baseline information. Unfortunately, the systemic lack of support and limited employment opportunities for wildlife biologists deterred most from pursuing this type of career . The situation gradually changed after the Earth Summit in 1992, during which the Bangladesh Government signed at Rio summit. As a signatory, the government was obligated to take the necessary actions to strengthen wildlife conservation as a part of the biodiversity conservation in the country. A new generation of academics become interested, and with the aid of donors committed to wildlife conservation a new momentum uplifted our wildlife research. Still, until 2000, studies were confined to behavioural ecology and systematic wildlife surveys. These studies were more comprehensive than previous work and an enormous amount data were generated..

At the start of the 21st Century wildlife studies in our country expanded dramatically. The use of technology like radio-collaring, camera trap and GPS tremendously strengthened our ability to study and collect data on the behavior and ecology of elusive wild animals. At the same time the development of molecular technology provided us ample opportunities to characterize ambiguous species and study the population genetics of our wildlife. This technology also facilitated our studies of bi-directional pathogen transmission between wild animals and humans, a very new dimension of wildlife research in our country. The last one and half decades are the golden era of our wildlife research during which more than 50 species of wild animals have been identified as new record in Bangladesh. The establishment of multi-dimensional research collaborations have generate an large datasets on our wildlife which in turn have been used for animal management and conservation. I propose that we prioritize the following areas of wildlife research:

Status and distribution: systematic longitudinal surveys are still scarce, data are available on some of the well known species and mega fauna. However, uncommon and rare species are not receiving sufficient attention. Since a large number of species have been newly recorded during the last decade, therefore, systematic surveys and monitoring are essential to assess the present status and distribution of our wildlife.

Behavioural ecology: data from synecology and autecology studies are essential for developing any management plan for wildlife. Studies on elusive and nocturnal animal are particularly critical as their lack of visibility makes them especially vulnerable. Ecological data are available on less than 10% of the mammalian and 5% of the bird species of the country. This sector should receive priorities to generate data which will eventually used for developing species specific management plan.

Population genetics: increasingly genetic studies have been shown to be essential for species identification and to enumerate population distribution of our wildlife. Recent genetic studies on frogs and rhesus macaques (Macaca mulatta) reveal a new frontier of wildlife research in our country and strongly justify the priority of research in this field.

Human-wildlife interaction: rapid horizontal expansion of human settlement severely impacts or destroys wildlife habitat of the country. As a result animals must either adapt to life within human settlements or find themselves confined in the leftover habitat. In either case, conflicts between wild animals and humans increase exponentially. These conflicts create the perfect scenarios for disease transmission and following priorities and strategies are essential for monitoring the human-wildlife interface in Bangladesh:

1. Longitudinal studies of genetic and viral diversity in key taxa (e.g. Primates, Birds, Rats, Bats)
2. Zoonotic studies (e.g. Simian retroviruses, Avian Influenza, Mycobacteria)

3. Developing predictive models (e.g. Risk Analysis, GIS)
4. Conservation management (e.g. integrating performing monkeys/snakes/elephants etc)

Longitudinal studies: Describing the geographic distribution and movement of host populations is critical to understanding the direction, rate and likelihood of spread of infectious agents. Characterizing the population structure and demographic history among species of interest in Bangladesh and describing how translocation and migration of these species leads to geographic spread, host switches and recombination of viruses can only be successfully done with long-term, longitudinal monitoring. Our continued focus on primates, birds, bats and rats reflects both the prevalence of these species in the habitats shared with humans as well as their demonstrated role in zoonotic disease transmission throughout the region.

Zoonotic Studies: Multiple non-human primate (NHP) species coexist with humans in different areas and ecological contexts in Bangladesh, one of the most densely populated countries in the world. Interaction among populations of NHPs, as well as between humans and NHPs, increases the likelihood of cross-species transmission of infectious agents. Our ongoing collaborative research, which we have carried out throughout the country and in collaboration with institutions in the USA, has characterized host and viral genetics and the zoonotic potential of Picornaviruses, simian retroviruses, avian influenza, and Mycobacteria in a variety of geographic areas and contexts throughout Bangladesh. Novel phylogenetic and phylodynamic analyses elucidated how these viruses have changed over time through co-evolution with their hosts, recombination and host switches. These microbiology studies were complemented by studies on the demographic histories of the NHP populations and human populations that have contributed to the movement of animals throughout the region.

Developing predictive models that are built upon the long-term, longitudinal studies: The interaction between viruses and animals (including humans) is dynamic and complex and takes place in a broad geographic space and over spans of time. A fuller appreciation of this complexity can be achieved by developing spatial analytical techniques encompassed in geographic information systems (GIS). GIS allows us to develop graphic illustrations that show the relationships between viruses, individuals and groups (of humans and animals) and geographic features. The use of GIS techniques will enable us to identify “hot spots” of increased viral genetic diversity/recombination as well as host genetic diversity. We anticipate that these data will provide insight into how anthropogenic factors influence the movement of viruses, animals and people and shape the landscape in which viral evolution occurs. The more comprehensive our sample of the viral, animal and human populations, the more detailed our appreciation of population variation and movement is likely to be. Thus, expanding our sample size and collecting longitudinal data, especially in areas we identify as “hot spots” for recombination and host switches, will enhance our ability to develop a rich understanding of the evolution and emergence of these infectious agents.

Epidemiologists have traditionally used maps to analyze associations between location, environment, and disease. GIS is particularly well suited for studying these associations because of its spatial analysis and display capabilities. GIS can place evolutionary change of hosts and infectious agents in the context of environmental changes that occur during the same time period. Changes to the environmental landscape include construction of infrastructure, such as roads and bridges, population movements including trade and emigration, and deforestation, which can impact migration of animal populations. This is a rich, diverse data set that harnesses a number of sources of data, including GPS readings, historical satellite images, and review of historical records. One of the important aspects of this component of the research is the correlation of genotypic variation with geographic features (such as major river systems, bridges, forested areas), natural phenomena (such as floods) and even historical events (such as significant migration of human population, such as occurred around the time of Bangladesh’s independence).

The use of GIS promises to enhance the quality of spatial and nonspatial data for analysis and decision making by providing an integrated approach to disease control and surveillance on a variety of local, regional and/or national levels. Future application of GIS may include using risk assessment models that combine GIS and logistic regression to identify “hot spots” for the likely the emergence of zoonoses and facilitate spatial analyses in our phylodynamics investigations.

Conservation

The conceptual level of Forest Department changed from revenue earning to biodiversity conservation after 1992 when the government signed the CBD and took some action to conserve our biodiversity. The consequences of this shift are evident over the last two decades during which the Forest Department not only updated the Wildlife Act but also undertook several initiatives to conserve our wildlife diversity. Although some of these actions were taken prior to the 90’s (e.g. 1978: The Sundarbans Wildlife Management Plan; 1984: Integrated development of the Sundarbans),

most occurred after 1992. More than 80% of the PAs in Bangladesh were declared after the Earth Summit in 1992. Bangladesh is a signatory to some international conventions, treaties and protocols (ICTP) including (i) Convention on International Trade in Endangered species of Wild Fauna & Flora (CITES) Washington, 1973; (ii) Convention on Wetlands of International Importance especially as Water fowl Habitat, Ramsar, 1971; (iii) Convention at the Earth Summit, 1992; (iv) Convention Concerning the protection of the World Cultural & Natural Heritage, Paris, 1972. (World Heritage Convention); (v) Convention on the conservation of Migratory species of Wild Animals Bonn. 1979 (CMS); (vi) Global Tiger Forum (GTF); (vii) 'MIKE' is a long term program for monitoring the illegal killing of elephants in the south Asia region; (viii) Convention on Biological Diversity, Rio de Janeiro 1992; (ix) International Convention to combat desertification, Paris 1994; (x) International plant protection Convention, Rome 1951; (xi) Vienna Convention for the protection of Ozone layer, Vienna 1985; (xii) United Nations Framework Convention on Climate Change, New York 1992; and (xii) Kyoto Protocol, 1996. MOEF (define this acronym) is mostly responsible to undertake national actions and also to take part in international meetings and negotiations concerning these ICTPs.. The Forest Department and Ministry of Agriculture are the authorities responsible for implementing ICTPs.

As a signatory of the Earth Summit, the Bangladesh Government established several programmes to support the implementation of the National Biodiversity Strategic Action Plan. Some of them are as follows:

1994. Wildlife Management Plan for the Sundarbans Reserve Forest (UNDP/FAO).
1995. Forest Resource Management Plan (FRMP).
1997. Conservation Management Plan of the Wildlife Sanctuaries in the Sundarbans Forests (World Bank).
1998. Integrated Resource Management Plan (IRMP) was prepared for improving the Sundarbans Reserved Forest (SRF).
1998. SEMP: UNDP funded project, being implemented to conserve important ecosystems and their resources.
2000. Sundarbans Biodiversity Conservation Project (SBCP).
2003. Coastal and Wetland Biodiversity Management at Cox's Bazar and Hakaluki Haor (CWBMP)
Nishorgo, IPAC, KREL and SRCWP are the series of project taken by the government funded by several donors for conserving our biodiversity last one decade.

Following are the focal areas upon which biodiversity programme of actions 2020 (BPA 2020) has been built on (According to CBD 2010).

Focal Area 1: Coastal and Marine Ecosystems Conservation
Focal Area 2: Agro-ecosystem and Agricultural Biodiversity Conservation
Focal Area 3: Wetlands Ecosystems and Fisheries Biodiversity Conservation
Focal Area 4: Hilly Ecosystems and Landscapes Conservation
Focal Area 5: Forest Biodiversity and Conservation of Wildlife
Focal Area 6: Biodiversity Conservation in the face of Climate Change
Focal Area 7: Poverty Reduction through Fair and Equitable Sharing of Benefits
Focal Area 8: Impact Assessment and Monitoring
Focal Area 9: Knowledge Management, Communication, Education and Public Awareness

Regulations related to implementation of NBSAP: Bangladesh has a number of laws that deal with the various aspects of the environmental issues. The following are the major legal instruments related to biodiversity.

- The Environment Conservation Act, 1995
- Environment Conservation Rules (ECR), 1997
- The Environment Court Act, 2000
- The Forest Act, 1927 (amendment in 1990, 2000)
- Protection and Conservation of Fish Act, 1950 (amendment in 1963, 1970m 1982m 1995, 2002)
- Protection and Conservation of Fish Rules, 1985 (amendment in 1987)
- Marine Fisheries Ordinance, 1983
- Agricultural Pesticide Ordinance, 1971
- The Fertilizer Regulation Order, 1995

National Policies related to implementation of NBSAP: The environmental policies of Bangladesh have mostly been formulated in the post-Rio era.

- The Environment Policy 1992
- Bangladesh National Conservation Strategy (NCS) , 1996
- National Environment Management Action Plan (NEMAP), 1996
- Biodiversity Conservation. Forest Policy, 1994

- Land Use Policy, 2001
- The Fisheries Policy, 1998;
- National Agriculture Policy, 1999;
- Livestock Development Policy, 1992;
- National Water Policy, 1999;
- Industry Policy, 1999;
- Energy Policy, 1995;
- Export Policy, 1997-2002
- National Science and Technology Policy, 1983.

Academic institutions/ research organizations can provide baseline data and guidelines for biodiversity management and conservation. These data and guidelines are the prerequisite for in-situ and ex-situ species level conservation but implementation and monitoring by the respective authorities is essential in any conservation programme. Certainly the involvement of local people and institution strengthens the process. Changing our attitude toward biodiversity and encouraging the participation of all concerned people / organizations is the only way to create a secure future for our remaining biodiversity.

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Diversity of pierid butterflies and their status in some forests of Bangladesh

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Abstract
Butterflies are generally regarded as one of the best taxonomically studied groups of insects. They are particularly sensitive to environmental variations. An attempt was made to study on "Diversity of Pierid butterflies and their status in some forests of Bangladesh" from January 2006 to December 2009. The research work has been carried out in seven selected study areas in forests of Bangladesh. The experimental stations were in Satchari, Lawachara, Anarashbari, Rema-Kalenga, Madhupur, Bhawal National Park and Curzon Hall Campus, University of Dhaka. Most species of butterflies were identified in the field. A few specimens of the species difficult in field identification were collected for the laboratory for further identification. During the course of study 11 genera and 24 species of butterflies belonging to the family Pieridae were recorded. The status of the butterflies were categorized as Highly Abundant (> 200 counting), Moderately Abundant (< 200-100 counting), Thinly Abundant (< 100-50 counting) and Rarely Abundant (<50 counting). About 25% were highly abundant, 37.5% were moderately abundant 20.8% were thinly abundant and 16.7% were rarely abundant (*Pieris canidia, Pontia daplidice, Appias albino, Hebomoia glaucippe*). The population was highest in Madhupur and Bhawal National Park and low in Anarashbari and Rema-Kalenga. On an average the population was high in Satchari, Lawachara and Curzon Hall Campus. The population was peaked during April to July and again in November to December. Low population abundance was noticed during January to March and August to September.

Introduction
Insects comprise more than half of earth's diversity of species (May, 1992). Butterflies are generally regarded as one of the best taxonomically studied groups of insects (Robbins et al. 1997). Butterflies are particularly sensitive to environmental variations (Robbins et al. 1997). Seven families of butterflies are found in Bangladesh, viz Papilionidae, Pieridae, Nymphalidae, Danaidae, Satyridae, Lycaenidae and Hesperidae (Bashar et al. 2005). Positive relations have been found between butterfly diversity and environmental variables, such as plant diversity (Erhardt 1985, Thomas et al. 1985, Leps et al. 1990, Spitzer et al. 1997), habitat complexity (Molina et al. 1996), landscape structure (Wood et al. 1992), topographic and moisture gradients (Kremen 1992) and climate (Pollard et al. 1993, Parmesan 1996). The pierid are a large family of butterflies with about 76 genera containing approximately 1100 species, mostly from tropical Africa and Asia (DeVries 2001). Butterflies are very much related with their host-plants (Scoble 1992). The diversity of butterflies is now decreased day by day as a result of climate change, loss of forest ecosystem (Molina and Palma 1996). Pierids utilize various plant species under the family Leguminosae for maintaining their developmental stages (Boggs 1987).

Materials and Methods
Study area
An attempt was made to study on "Diversity of Pierid butterflies and their status in some forests of Bangladesh" from January 2006 to December 2009. The research work has been carried out in seven selected study areas (forests) of Bangladesh. The experimental stations were Satchari, Lawachara, Anarashbari, Rema-Kalenga, Madhupur, Bhawal National Park and Curzon Hall Campus, University of Dhaka. Site selection was made according to the procedures of Marsh and Greer (1992) and Walpole and Sheldon (1999). The descriptions of the selected area are given below.

Satchari: It is located at Chunarughat Upazila under Hobiganj District. The forest is a remnant of the tropical evergreen and semi-evergreen forests that once covered the Sylhet division and ran down to the Chittagong hill tracts. The butterfly-species composition giving an example of the best situation of indicators of stabilized tropical forest.

Lawachara: It is a reserve forest and National Park situated at Srimongal in Moulvibazar district, Sylhet Division. It is a natural evergreen rainforest with diversified flora and fauna. Considerable numbers of butterflies are found on flying, searching and foraging on flowers and plants.

Anarashbari: This station is under Bahubalthana, in Hobiganj district. It is situated beside the highway. It is a cultivated area with a lot of Rutaceae, Citrus (Citrus aurantifolia) plantation. Soil layer of this place is densely coated with small grasses and slope of this area is small hilly land; and scattered by distributed with some bushes and hedges. Considerable numbers of butterflies are found on flying, searching, and foraging on flowers and plants.

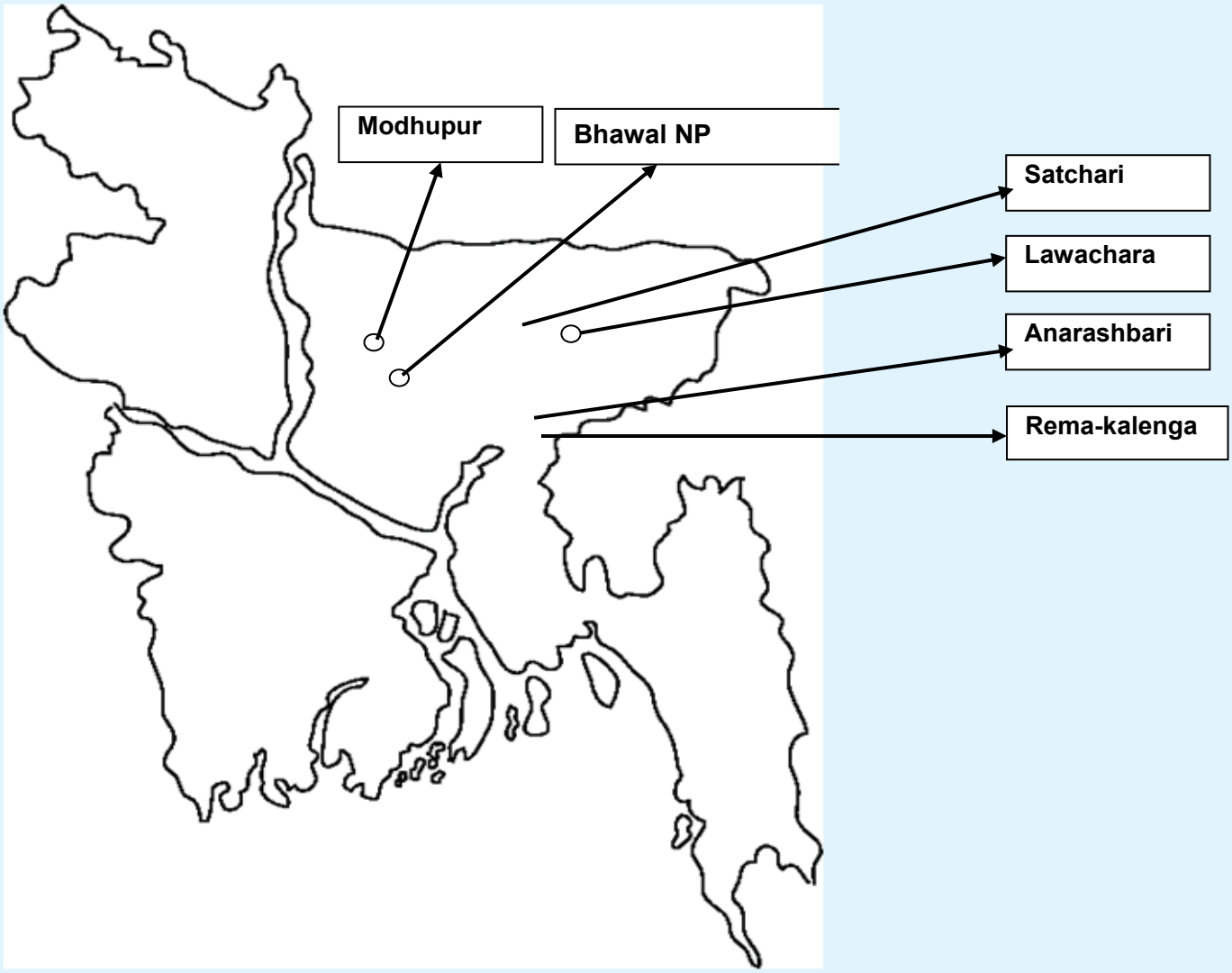

Fig.1.Various research stations in different forest areas of Bangladesh

Rema-Kalenga: Rema-Kalenga is situated in the south side of Hobiganj districts and continued up to Tripura of India. It is a tropical forest with natural and cultivated plantations under Kalenga beat. Butterflies are nymphalids, pierids and satyrids.

Madhupur: It is a national park of Bangladesh, which is located in Tangail district. Three sub-stations were selected for butterfly behavioural study and sampling. They were Charaljani, Rasulpur, and BAF Firing Range. It is a deforested spot with some herbs and shrubs. This station is a multicultural forest with full of canopy trees. Dominated trees are Sal and banyan trees. Butterflies varieties are more abundant here.

Bhawal National Park: It is situated in Gazipur district, 40 kilometers north of Dhaka City. It is on the Dhaka-Trishal-Mymenshingh highway. It is a green, shady place. It is calm and quite, free from urban chaos. The major vegetation of this reserved forest is Sal (*Shorea robusta*) and Australian Phyllode Acacia (*Acacia auricoliformis*). Considerable numbers of butterflies are found on flying, searching, and foraging on flowers and plants.

Identification of butterfly species

Identification of the butterflies was primarily made directly in the field. In critical condition, specimens were collected and carried them to the laboratory for further identification. The principal characters used in identifying adult butterfly are

those of the wings and wing venation. Other characters used include the character of the antennae and legs and frequently such general features as size and colour (Borror et.al.1981). The specimens were identified up to genus and species level. At last total population, number of species, their population, seasonal variation etc. were counted and were find out rare and available species.

Results and discussion

During the course of study 11 genus and 24 species of the family Pieridae were recorded. The number of specimen was recorded in the genus Catopsilia (3 species; 826 specimens, i.e. *C. crocale, C, Pomona and C. pyranthe*). 4 Eurema species were recorded with 753 specimens (*E. blanda, E. hecabe, E. simulatrix and E. andersoni*). 1 Leptosia species was recorded with 499 specimens (L. nina). A total of 4 Delias species were recorded with 368 specimens (*D. descombesi, D. pasithoe, D. eucharis and D, hyparete*). The genus Appias was recorded with 3 species (*A. lyncida, A. olfernaand A. albina*) by collecting 281 specimens. 1 Gandaca species was recorded with 172 specimens (G. harina). 1 Cepora species was recorded with 159 specimens (*C. nerissa*). The genus Pareronia was recorded with 2 species (P. ceylanica and P. hippia) by collecting 99 specimens. The genus Pieris was recorded with 3 species (*P. rapa, P. brassica and P. canidia*) by collecting 98 specimens. 1 Pontia species was recorded with 16 specimens (*P. deplidice*). 1 Hebomoia species was studied with 6 specimens (*H. glaucippe*). The butterflies were categorized in four statuses as Highly Abundant, Moderately Abundant, Thinly Abundant and Rarely Abundant.

Table 1 shows that, about 24 species of pierid butterflies 25% were highly abundant, 37.5% were moderately abundant, 20.8% were thinly abundant and 16.7% were rarely abundant.

Table1. Observed and identified species of Pierid butterflies and their status in different stations of Bangladesh

Common name	Scientific name	Status	Stations
The Common Emigrant	*Catopsilia crocale*	HA	CZH, LC, BNP, MT, SC, AB, RK,
The Lemon Emigrant	*Catopsilia pomona*	HA	CZH, LC, BNP, MT, SC, AB, RK
The Mottled Emigrant	*Catopsilia pyranthe*	HA	CZH, LC, BNP, MT, SC, AB, RK
The Common Grass Yellow	*Eurema hecabe*	HA	CZH, LC, BNP, MT, SC, AB, RK
The Three Spotted Grass Yellow	*Eurema blanda*	HA	CZH, LC, BNP, MT, SC
The Psyche	*Leptosia nina*	HA	CZH, LC, MT, BNP, SC, AB
The Striped Albatross	*Appias olferna*	MA	BNP, MT, LC, CZH
The Chocolate Albatross	*Appias lyncida*	MA	MT, LC, SC, BNP, CZH
The Common Gull	*Cepora nerissa*	MA	BNP, MT, CZH, SC, LC, AB
The Common Jezebel	*Delias eucharis*	MA	BNP, MT, LC, CZH, SC
The Red-spot Jezebel	*Deliasdes combesi*	MA	BNP, MT, LC, CZH, SC
The Hill Grass Yellow	*Euremas imulatrix*	MA	BNP, MT, CZH, SC, LC, AB
The One Spotted Grass Yellow	*Eurema andersoni*	MA	BNP, MT, LC, CZH
The Dark Wanderer	*Pareronia ceylanica*	MA	MT, BNP, SC, LC
The Tree Yellow	*Gandaca harina*	MA	LC, SC
The Painted Jezebel	*Delias hyparete*	TA	BNP, MT, SC, LC
The Redbreast Jezebel	*Delias pasithoe*	TA	MT, BNP, SC, LC
The Common Wanderer	*Pareronia hippie*	TA	MT, BNP, SC, LC
The Small Cabbage White	*Pieris rapae*	TA	MT, LC, AB, CZH,
The Large Cabbage White	*Pieris brassicae*	TA	MT, LC, AB, CZH,
The Indian Cabbage White	*Pieris canidia*	RA	MT, LC, AB, CZH,
The Bath White	*Pontia daplidice*	RA	MT, SC
The common albatross	*Appias albina*	RA	CZH, MS
The Great Orange Tip	*Hebomoia glaucippe*	RA	LC

Stations: CZH- Curzon Hall, LC- Lawachara, BNP-Bhawal National Park, MT- Madhupur, RK- Rema-Kalenga, SC-Satchari, AB- Anarashbari.

Status: HA- Highly abundant (> 200 counting), MA- Moderately abundant (< 200-100 counting), TA- Thinly abundant (< 100-50 counting), RA- Rarely abundant (<50 counting).

Pierid butterflies were found fluctuated from one station to another. The population richness mainly depends on the richness of nectaring plants, availability of host plants and also presence of their resting plants. Their population richness also depends on the presences of different types of vegetation such as underground, man height and canopy. On the other hand their population decline due to the absence of host and nectaring plants. Human interference and deforestation also is major key factor for diminishing of butterfly population.

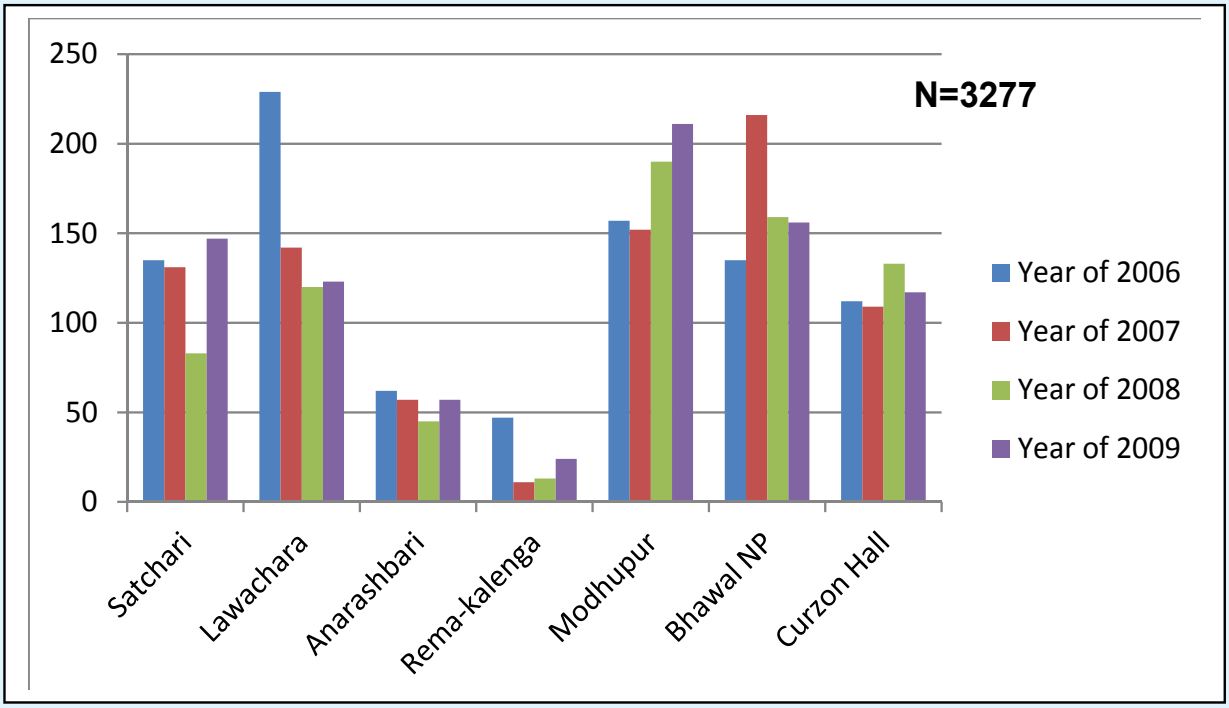

Fig. 1 Seasonal distribution and fluctuation in abundance of pierid butterflies in different forest areas of Bangladesh (2006 to 2009)

It was found that the population was highest in Madhupur forest area and it was lowest in Rema-Kalenga. Out of 3277 observed specimens 710 were found in Madhupur, 666 were in Bhawal NP, 614 were in Lawachara, 496 were in Satchari, 471 were in Curzon Hall, 221 were in Anarashbari and 95 were in Rema-Kalenga forest area. On the other hand the population was found highest in the year of 2006. In 2008 it was found low-status and on average the population was recorded high in the year of 2007 and 2009 (Fig. 1)

During the study period 11 genus and 24 species of the family Pieridae were recorded and identified. The record was made from the different forest stations of Bangladesh. The peak abundance of Pierid population was found from April to July and again from November to December. It was lowest from January to March as well as from August to September. The study revealed that the Pierid butterflies are biotic indicators and can play a significant role in biodiversity conservation and climate change forecasting.

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Effects of stocking density of endangered *Labeo bata* (Hamilton, 1822) with carp polyculture in ponds

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Abstract
The present study was conducted to evaluate the growth performance of endangered *Labeo bata* with carps under different stocking densities for a period of six months from June, 2011 to November, 2011 in 9 experimental ponds under department of fisheries, University of Rajshahi. The experiment was conducted under three treatments each with three replications namely T1: (Carp-7000 + *Labeo bata*-2000) individuals/ha; T2: (Carp-7000 + *Labeo bata*-3000) individuals/ha; T3: (Carp-7000 + Labeo bata-4000) individuals/ha. During the present study, urea, TSP and cow dung were applied to all the treatments at the rate of 100 g/dec, 50 g/dec and 4 kg/dec respectively as basal dose whereas it was applied at the rate of 100 g/dec, 50g/dec and 3 kg/dec respectively on monthly basis. Supplementary feeding (viz., rice bran 40%+wheat bran 30%+mustard oil cake 30%) was done for all treatments twice a day at the rate of 5% of the total body weight of stocked individuals. Water quality parameters were monitored fortnightly. Among the water quality parameters dissolved oxygen, carbon-di-oxide and ammonia-nitrigen were varied significantly ($p<0.05$). Growth parameters were mentioned on monthly basis. Significantly higher weight gain and SGR were recorded in T2 followed by T1 and T2. A simple economic analysis revealed that higher cost-benefit ratio was obtained in treatment T2 followed by treatment T1 and treatment T3. Therefore, it is concluded that the highest production and economic benefits was achieved for both endangered *L. bata* and carp with the treatment T2.

Keyword: *Endangered, Labeo bata, Polyculture, Stocking density*

Introduction
Polyculture is a popular way to raise fish in which fast growing compatible species of different feeding habits of same age group are stocked in different proportion in the same pond (Jhingran, 1975). It has been practicing from the very beginning of the fish culture in China and Indian sub-continent. The basic principle of fish polyculture, i.e. culture of species of different feeding habits in the same aquatic environment, is the best utilization of natural foods of different strata and zones without any harm to each other (Halver, 1984). This principle based on the assumption that fish growth is an expression of their reaction to among other things, the sources of natural food in the environment (Stephered and Bromage, 1992). If stocked in appropriate numbers and ratios relative to the pond size, multiple species of fish in the same pond can actually produce a larger volume of each type of fish when compared to single-species ponds (Mustafizur et al., 2008). Polyculture methods of aquaculture can help in ensuring food security for many rural communities in Bangladesh. By making aquaculture more productive, polyculture increases both the food available to rural communities and provides a source of income for farmers (Alan Lowther, 2004).

Labeo bata (Hamilton, 1822) is an indigenous carp of South-East-Asia which is locally known as Bata or Vhagon in Bangladesh. This fish was once abundantly available in the open water floodplains, canals, beel and haors of Bangladesh. But due to over exploitation and various ecological changes in its natural habitat; this species is endangered (IUCN, Bangladesh 2000).There is a little or no information on stocking density and production performance of indigenous carp *Labeo bata* under polyculture system in Bangladesh. The present study was undertaken to evaluate the effects of stocking density of the carp on production with other carps in pond in Bangladesh.

Materials and Methods
Time and Location of the study
The experiment was conducted for a period of six months (June to November, 2011) in research pond of Department of Fisheries, University of Rajshahi.

Experimental Design
The current research was carried out under three treatments (T_1, T_2, T_3), each with three replications. In each treatment, the stocking density of *Labeo bata* was varied with the other cultured carp fishes.

Table 01: Experiment design showed the number of fish species per hector

Fish species	Treatments (number/ha)		
	T_1	T_2	T_3
H. molitrix	2000	2000	2000
C. catla	1000	1000	1000
L. rohita	1000	1000	1000
B. gonionotus	500	500	500
C. idella	1000	1000	1000
C. mrigala	1500	1500	1500
L. bata	2000	3000	4000

Nine similar size ponds were used for this experiment. The average area of the ponds was 0.60 decimal (0.0024 hector). The water depth was maintained around 1.0-1.25 m. The ponds were rectangular in shape, well exposed to sunlight and completely free from aquatic vegetation.

Pond preparation

All unwanted fishes and other aquatic organisms were eradicated by netting. Lime was used in the experimental ponds at rate of 1 kg/decimal.. All ponds were fertilized Urea, TSP and cow dung at the rate of 100g, 50g and 4 kg/dec., respectively as basal dose.

Stocking and post stocking management

Labeo bata and different carp fish fingerlings in different treatments were stocked. *Labeo bata* was stocked at a density of 8, 12 and 16/dec in T1, T2 and T3 respectively. Other carp fingerlings were stocked at a density of 28/dec. After stocking of fish feeding, fertilization, fish sampling and pond water quality were monitored regularly during the culture period. During the study period, urea, TSP and cow dung were applied at the rate of 100 g/dec, 50g/dec and 3 kg/dec respectively on monthly basis. Supplementary feeding (viz., rice bran 40%+wheat bran 30%+mustard oil cake 30%) was done for all treatments twice a day at the rate of 5% of the total body weight of stocked individuals.

Water quality monitoring

Water quality measurements and sample collection were made between 9.00 h and 10.00 h on each sampling day. Water temperature (°C), Transparency (cm), pH, carbon-di-oxide (mg l-1), dissolved oxygen (mg l-1), Total alkalinity and NH3-N (mg l-1) were measured at regular intervals by using standard methods.

Growth parameters

Monthly sampling of fish was done to check the health condition. Feeding rate was calculated from the average weight of fish for each period. Ten random samples of fish were taken to make some rough assessment of growth trends. At the end of the experiment, fish and freshwater prawn were harvested and counted for total number separately. Weight gain (g), Specific growth rate (SGR%), survival rate (%), and net yields (kg/ha) were calculated.

Statistical analysis

For the statistical analysis of the data, a one-way ANOVA and DMRT were done by using the SPSS (Statistical Package for Social Science) version 16. Significance was assigned at the $P<0.05$ level of significance. Duncan's test was used to determine the results of multiple ranges for comparisons of averages.

Results

Water quality parameters

Water quality parameters of a large number of samples were analyzed (Table 2) in this experiment to observe any appreciable changes that might have occurred. Water quality parameters were monitored fortnightly. Water temperature, water transparency, dissolved oxygen, free carbon dioxide, pH, ammonia-nitrogen and total alkalinity of water varied from 25.57±0.22 to 32.67±0.17°C, 25.40±1.38 to 35.63+0.77 cm, 3.15±0.07 to 5.77±0.04 mg/l, 6.37±0.23 to 9.98±0.11 mg/l, 7.20±0.30 to 7.83±0.07, 0.0010+0.00 to 0.0080+0.002 mg/l and 62.72±2.99 to 106.11±4.42 mg/l respectively. Among the parameters carbon di-oxide, ammonia-nitrogen and alkalinity were varied significantly ($P<0.05$). Variation in the mean values of water quality parameters in three different treatments were showed in Table 02.

Table 02: Variation in the mean values of water quality parameters in three different treatments during the study period

Parameters	Treatments		
	T_1	T_2	T_3
Temperature (°C)	30.54±0.68[a]	30.38±0.62[a]	30.50±0.70[a]
Transparency (cm)	27.93±0.74[a]	28.87±0.78[a]	29.17±0.99[a]
Dissolved Oxygen (mg/l)	5.25±0.10[a]	5.20±0.09[a]	5.05±0.26[a]
CO_2 (mg/l)	7.30±0.16[b]	7.43±0.09[a]	8.58±0.27[a]
pH	7.56±0.03[a]	7.54±0.02[a]	7.42±0.04[a]
NH_3-N_2	0.0011±0.0[b]	0.0012±0.0[b]	0.0038±0.0[a]
Alkalinity (mg/l)	89.39±1.93[a]	92.89±2.40[a]	83.97±3.22[b]

Figures in a row bearing common letter do not differ significantly (P<0.05)

Growth and production of fish

There was no significant difference (P<0.05) of initial weights of fish among the treatments. The average mean initial weights of *H. molitrix, C. catla, L. rohita, B. gonionotous, C. idella, C. mrigala* and *L. bata* were 30.47±0.51g, 25.21±0,38g, 11.96±0.43g, 20.21±0.86g, 15.01±0.12g, 28.15±0.08g and 15.32±0.25g respectively. The final weight of *H. molitrix* ranged from 338.15g to 410.52g, *C. catla* 291.21g to 3320.27g, *L. rohita* 145.61g to 192.41g, *B. gonionotus* 108.54g to 161.87g, *C. idella* 194.21g to 254.11g, *C. mrigala* 110.14g to 135.24g and *L. bata* 117.14g to 141.21g, respectively (Table 03).

Table 03: Mean values of final weight and specific growth rate in different treatments

Characteristics	Treatments		
	T_1	T_2	T_3
Mean Final weights (g)			
H. molitrix	396.01±1.82[a]	392.05±1.34[b]	346.59±2.33[c]
C. catla	312.59±2.04[b]	320.28±0.90[a]	298.90±2.66[c]
L. rohita	185.89±1.13[a]	183.59±3.87[b]	152.00±1.01[c]
B. gonionotus	152.20±0.95[b]	156.35±1.17[a]	116.06±1.01[c]
C. idella	245.93±1.23[b]	250.68±1.45[a]	200.54±1.02[c]
C. mrigala	128.65±1.43[b]	135.67±1.83[a]	117.32±1.58[c]
L. bata	131.28±1.87[b]	150.30±1.43[a]	122.24±2.00[c]
SGR (%, bwd-1)			
H. molitrix	1.42±0.02[a]	1.42±0.01[a]	1.35±0.01[a]
C. catla	1.40±0.02[a]	1.41±0.01[a]	1.37±0.01[b]
L. rohita	1.23±0.02[a]	1.22±0.01[a]	1.12±0.01[c]
B. gonionotus	1.28±0.03[b]	1.30±0.02[a]	1.13±0.02[b]
C. idella	1.20±0.02[a]	1.21±0.01[a]	1.09±0.01[b]
C. mrigala	1.18±0.02[b]	1.21±0.01[a]	1.13±0.01[b]
L. bata	1.33±0.02[b]	1.40±0.01[a]	1.29±0.01[c]

Figures in a row bearing common letter do not differ significantly (P<0.05)

The mean final weights of *L. bata* are 131.28±1.87g, 150.30±1.43g and 122.24±2.00g in T_1, T_2 and T_3 respectively (Table 03). In case of all fish species the highest SGR was observed in *H. molitrix* followed by *C. catla, L. rohita, B. gonionotous, C. idella, L. bata* and *C. mrigala* (Table 03). Significant difference (p<0.05) were found among the treatments for the weight gain and SGR.

Table 04: Mean values of survival rate and production in different treatments

Characteristics	Treatments		
	T_1	T_2	T_3
Survival rate (%)			
H. molitrix	90.08±3.12	88.05±2.89	85.25±2.58
C. catla	90.95±2.17	86.78±1.77	84.41±1.65
L. rohita	86.56±1.72	85.21±1.87	82.06±1.82
B. gonionotus	89.15±2.81	93.32±1.78	87.88±1.36
C. idella	88.15±2.31	91.15±1.88	86.35±1.53
C. mrigala	86.32±2.89	90.56±2.12	85.32±1.89
L. bata	88.85±2.11	92.06±1.89	83.91±1.57
Production (kg/ha)			
H. molitrix	657.00±4.25^a	645.21±3.54^a	534.28±3.63^b
C. catla	255.77±2.14^a	252.97±2.01^a	228.21±1.89^b
L. rohita	306.90±3.17^a	303.40±2.98^a	241.84±2.14^b
B. gonionotus	60.96±1.10^a	65.10±1.32^a	43.06±0.98^b
C. idella	190.96±2.14^a	202.94±3.13^a	147.92±1.98^b
C. mrigala	148.03±2.15^b	162.11±2.89^a	128.78±1.89^c
L. bata	209.44±3.12^b	254.25±4.12^a	177.12±2.89^c

Figures in a row bearing common letter do not differ significantly (P<0.05)

The survival rate of fishes were higher might be due to the good quality seed and stocking of larger fingerlings. The average net yield of *H. molitrix, C. catla, L rohita, B. gonionotus, C. idella, C. mrigala* and *L. bata* varied from 612.36±3.64, 245.65±2.14, 283.33±2.51, 54.67±1.11, 179.71±2.41, 146.33±2.54 and 213.33±3.15 kg/ha/year respectively. Significant difference (P<0.05) were found among the treatments for the yield of all fishes.

Economic return

The economic analysis of fish production of each treatment was given in Table 05. The analysis was based on the local market price for fish and all other items, expressed in Bangladesh Taka (BDT). The economic analysis revealed that significantly higher (P<0.05) net return was observed in T_2 treatment compared to other treatments.

Table 05: Economics of different treatments

Parameters	Treatments		
	T_1	T_2	T_3
Total cost (Tk/h)	138890.41±580.21^a	141741.33±625.08^a	143398.33±745.08^a
Total Returns (Tk/h)	248805.2±890.23^a	266840.5±998.65^a	203362.5±784.40^b
Net Benefit (Tk/h)	109914.79±421.01^a	125099.17±512.12^a	59964.17±214.31^b
Cost benefit ratio (CBR)	1:0.79^a	1:0.88^a	1:0.42^b

Figures in a row bearing common letter do not differ significantly (P<0.05)

Discussion

The growth and performance of aquatic organisms depend on the water quality of a water body. Water quality includes all physical and chemical parameters that may affect aquatic production. Temperature is an important water quality parameter which was found to vary from 30.38±0.62°C (T_2) to 30.54±0.68°C (T_1) in ponds. Wahab et al. (1995) recorded the water temperature were from 27.2 °C to 32.4 °C in their experimental ponds in Mymensingh?. Boyd (1998) reported that the suitable water temperature of 25-32°C for warm water aquaculture species. Hossain and Bhuiyan (2007) stated that water temperature for pond fish culture were 29.72-30.49°C and 20.4-33.2°C, respectively from Rajshahi region which are more or less similar to the present findings.

The mean value of water transparency was differed from 27.93±0.74 (T_1) to 29.17±0.99 (T_3) cm. Rahman (1999) recorded transparency ranged from 12 cm to 46 cm and Boyd (1982) suggested that transparency range from 15 cm to 40 cm is good for fish culture. Wahab et al. (1995) recommended the secchi disc reading between 26 to 50 cm for fish culture. The concentration of dissolved oxygen in the experimental ponds ranged from 4.55±0.26 (T3) to 5.25±0.10 (T1) mg /l which was also similar to the findings of Hossain and Bhuiyan (2007), who recorded the DO values were of 3.87 to 5.85 mg/l.

Rahman (1992) reported that the range of pH of a suitable water body for fish culture would be 6.5 to 8.5. pH in experimental ponds and were varied from 7.42±0.04 (T_3), to 7.56±0.03 (T_1), similar to the findings of Hossain et al. (1997). Wahab et al. (1996) recorded that NH3-N in his study of 0.007 to 0.023 mg/l. BAFRU (1990) recommended ate NH3-N less than 0.025 mg/l in culture pond. During the study the total alkalinity was varied from 83.97±3.22 (T_3) to 92.89±2.40 mg/l (T_2). Total alkalinity more than 20 ppm in fertilized ponds is good for fish culture (Boyd, 1982). Banerjea (1967) and Bhuiyan (1970) recorded alkalinity in their experiments which ranged from 20 to 200, 25 to 100 ppm, respectively. The fluctuations of most of the water quality parameters in the treatment ponds were largely due to seasonal influence, accumulation of faecal metabolites, unused feed, resultant biomass increase with the progress of culture and intermittent fertilization and liming. However, no marked variations in any of the parameters were observed among the treatments, The parameters recorded were within the optimum range for carps (Banerjea1967; Jena et al 2002).

Significant difference was found among the treatments for the mean values of final weight. Hossain and Islam (2006) who reported the final weight of *L. rohita* 250.6 to 256.6 g. These results more or less agree with Hossain and Akhteruzzaman (2007) who reported the final weight of *H. molitrix* and *C. catla* 669.2 to 421.9g respectively. In case of specific growth rate (SGR), significant difference also observed in the treatments. All these findings were more or less similar with Hossain and Islam (2006).

The survival of fishes were higher might be due to the good quality seed and stocking of larger fingerlings. Species wise survival rate (%) in different treatments shows very little variations except *L. rohita*. The survival rate of *L. rohita* is more or less similar with Hossain and Kibria (2006) who reported that range from 87.5 to 92.5%. Jena (2008) recorded highest survival rate of silver carp (94–96%) followed by olive barb (87–90%), mrigal (72–74%), rohu (72–73%) and catla (67–69%).The productions of fishes in different treatments were found to vary among treatments due to difference in survival and growth rate. A significant difference was observed in the net yield in different treatments. The yield was calculated on per hectare basis over a 180 days culture period. The highest net and gross yields were found in T_2 may be due to proper food utilization, most suitable water quality condition in different water strata. Lower yield of catla fish in the present study was found due to its short culture period. On other, the highest yield of silver carp was found in all treatments where the lowest production of catla was recorded and vice-versa (Paul, 1998; and Hossain, 2006).

Significant difference was observed in case of *L. bata* production, higher in T_2 (254.25±4.12) followed by T_1 (209.44±3.12) and T_3 (177.12±2.89). These findings were strongly agreed with the polyculture system by Hossain and Akhteruzzaman (2007).

Hossain et al (1998) and Kohinoor et at (1993) also found more or less similar production in carp culture system. The cost-benefit ratio was obtained higher in treatment T_2 followed by treatment T_1 and treatment T_3.

It may be concluded that, though *B. gonionotus, C. idella* and *C. mrigala* yields were lower in presence of *L. bata* but bata addition into the polyculture led to higher total yields. Gross yield of fishes in treatment T_2 was significantly higher than T_1 and T_3 indicated that it is suitable species combination for pond aquaculture. It also indicated that feed efficiency was maximum and net return was significantly higher in treatment T_2 compared to other treatments. From this research it was revealed that addition of *L. bata* in higher density may be suitable for polyculture in rural farms and would allow commercial production as well as conservation of this native endangered species in Bangladesh.

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Fishery and biology of eel, *Monopterus cuchia* in the south-west coastal area of Bangladesh

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Abstract
The *Monopterus cuchia* is a dwindling species in Bangladesh. A large group of poor low caste religious minorities harvest cuchia from the characteristic semi-saline habitats of shrimp ghers or farms, cricks and canals in the South-west of the country. The fishery extant of cuchia in the South-West coastal areas of Khulna and Satkhira districts and some biology of the species were studied. Data were collected from 54 households with 109 fishermen through a structured questionnaire. Foods of cuchia were consisted of aquatic insects, small fishes, frogs and shrimp. The breeding season of cuchia lasts from April to July and August. The total length and weight of the specimens ranged from 26.67-66.15cm and 10-210g respectively. The co-efficient of correlation 'r' for the regression of total length and body weight was 0.98378, having high significance at 1% level. Harvesting takes place throughout the year. The peak season was from November to March. During peak season a fisherman could catch up to 7 kg cuchia per day and could sell at Tk. 30-40/kg. Cuchia is marketed alive and there is a marketing system of cuchia in the areas concerned. The harvests are locally sold. The cuchia harvesters and their ethnic compatriots is are the principal customers for the cuchia. Other than used as food for humans, cuchia is prominently used as bait for catching crabs in the Sundarbans. Considering the socio-economic and biodiversity importance of cuchia, the fishery of the species should be conserved for sustainable management.

Introduction
The South-West of the country comprising the greater Khulna areas has a big potential for contribution to the fisheries. There are 1, 26,989 brackish water shrimp ghers with an area of 1, 40,700 ha. The rivers and estuarine waters in greater Khulna stand at a total of 2, 32,405 ha. The total number of fishermen in the area approximates 75249. Khulna region has been endowed with yet another big fishery from the waters of mangrove Sundarbans. Other than being important for fish and shrimp, the area has promise for other fisheries like crab, cuchia or eels and crocodiles etc.

Cuchia or eels belongs to the Family Symbranchidae under the Class Actnopterygii. They are eel shaped and brownish in color. A rudimentary dorsal fin originates from a little anterior and vertical to anus. There are numerous spots all over the tail region (Talwar and A.G. Jhingran, 1991). They breed in summer. Feeding mainly on small fishes, tadpoles and aquatic insects, cuchia hibernate in mud during winter season (Rahman, 1989).

Geogphically they are distributed mainly in Pakistan, India, Nepal, Bangladesh and Myanmar. The species *Monopterus cuchia* hitherto was reported only from the freshwaters of Bangladesh. A large number of poor generally from low caste Hindus are actively involved in cuchia fishery activities in the area. The harvesting is done mainly from the ghers and flood plains. Other than being used as food by Hindus, cuchia is prominently used as bait for catching crabs. The present investigation on its extant in the semi-saline waters and role in fishery and livelihoods of poor people of the region was interesting.

This study, however, was based on the following objectives:
- To know the biology and ecology of *Monopterus cuchia*
- To obtain information relating to the fishery of the species

Materials and Methods

The South-west coastal shrimp ghers, flood plains, cricks and tidal rivers are rich in cuchia fishery. The two districts of the area - Khulna and Satkhira covering Dakop, Batiaghata, Koyra, Paikgacha, Kaligonj, Ashasuni and Debhata were selected for the study. A reconnaissance survey was done at first and based on that a detailed structured questionnaire was prepared for relevant information on fishery and biology of cuchia. Fifty four households with 109 fishermen were interviewed. The collected data were carefully edited for possible errors and analyzed with MS excel.

Results and Discussion

In Bangladesh cuchia is available in Chittagong Hill Tracts, Karnafuli reservoir, and Mymensingh (Anon, 1996). The principal habitats of occurrence of cuchia in the South-west were brackish water shrimp gher. During dry winter months

when shrimp culture goes on they were not available as much as they were after summer, at the onset of winter during November to March.

The male and female Cuchia are morphologically indistinguishable. Generally the male is larger than the female. They have no specialized organ for sexual difference. They are eel like and the cross section is round. Mouth is terminal. A rudimentary single dorsal fin originates from a little anterior and vertical to anus. There are numerous spots in all over tail area (Rahman, 1989).

Nelson (1996) stated that cuchia do not have pectoral and pelvic fins; dorsal and anal fins are rudimentary. The caudal fin is rudimentary, or absent. Eyes are small. Gill membranes are fused; gills open in a small slit. Four to six branchiostegal rays are present. There is no swim bladder; no rib bones present in them. They are mostly air breathers. Many are burrowers; there are some cave dwellers also. They get to a maximum of 70 cm in total length. They have two stages of their life cycle - juveniles and adults.

Figure 1. *Monopterus cuchia*

Rahman (1989) did not mention Cuchia availability from the coastal saline fronts of the country; a comparison on the salient morphometric characters of specimens from the coastal and inland fresh waters was interesting. The following body proportions were obtained.

Proportions	Specimen from semi-saline habitat	Specimen from freshwater habitat
Head : TL	1: 13.103	1: 11.132
Preorbital : HL	1: 7.259	1 : 8.833
Postorbital : HL	1: 3.500	1:1.341
Eye orbital to mouth gap : HL	1: 9.666	1: 5.888
Branchial opening: HL	1:3.052	1:2.864
Anus to tail end: TL	1:3.653	1:4.436

The specimens from the two habitats differ in all the six different body proportions. There can be further study on the taxonomy of the populations available in the country.

Cuchia inhabit freshwaters, lakes, brackish waters, caves, estuaries, lagoons, mangrove, marshes, swamps etc. (Talwa and Jhingran, 1991). In the present study they were found to inhabit in ghers and beels. They were reported to survive easily in muddy water condition. The fishermen reported that Cuchia burrow holes in the drying mud and can stay in the holes for sometimes before the mud is completely dried. They further mentioned that the cuchia holes normally have three openings. The survivability of cuchia is very high even in harsh condition.

Foods of cuchia were reported to be consisted of aquatic insects, small fishes, frogs and small shrimp however, the fishermen could not definitely tell their feeding habits. Food and feeding habits of cuchia were done by some authors. Talwar and Jhingran (1991) reported that there is not a consistent pattern of food and feeding habit of cuchia, however they generally classified as an omnivorous and predator.

Table1. Food items of *Monopterus cuchia* (Srestha, 1990)

Food I	Food II	Food III	Food name	Country	Predatory stage
Necton	Fin fish	Bony fish	Unspecified fin fishes	Nepal	Juveniles/adults
Others	Herbs	Toad/frogs	Unspecified tad-poles	Nepal	Juveniles/adults
Zoo benthos	Insects	Insects	Unspecified aquatic insects	Nepal	Juveniles/adults

The breeding season of cuchia starts from April and continues up to July and August. Spawning usually takes place at night in the shallow inundated areas of the ghers. Courtship is preceded by highly aggressive encounters between males. Breeding takes place in shallow waters between isolated pairs of males and females. After breeding the eggs are placed in the hole and larvae are produced after hatching.

Narejo, Rahmatullah and Rashid (2002) suggested association of gonadal maturation and onset of rain. De Graaf (1995) studied the gonadosomatic development in cuchia and suggested their breeding to start in March with the onset of rains lasts up to July. Sex chromosomes are not distinguishable in cuchia with any banding technique used. There is no parental care. Development of eggs and larvae is rapid and the larvae are capable of swimming within 48-72 hours. They have mainly two stages – juvenile and adult (Khuda Bukhsh, 1975).

The average length and weight of the species were recorded at 48.87 cm and 67.57 g respectively. The length- weight relationship of cuchia was on 54 specimens. The total length and weight of the specimens ranged from 26.67 – 66.15 cm and 10 - 210 g respectively. The relation between the total length and weight is shown in the following regression equation:

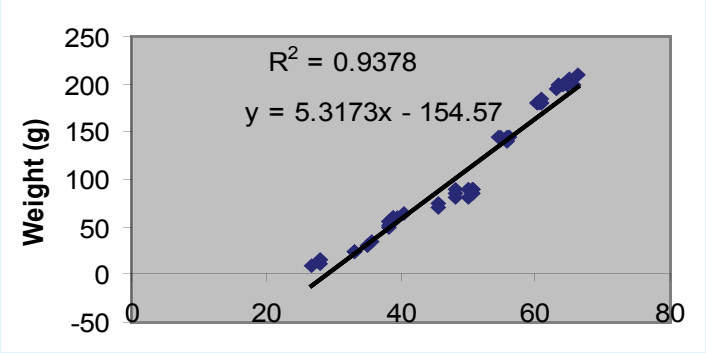

Figure 2. Length Weight relationship

The equations showed the exponential values were practically identical. The co-efficient of correlation 'r' for the regression of total length and body weight was estimated at 0.9378, showing high significance at 1 % level. The agreement between the empirical values and the computed values from regressions can be termed as satisfactory.

Narejo, Rahmatullah and Rashid (2002) observed total length ranging from 19.0 - 79.7 cm and weight from 7.6 to 210g in 146 specimens of *Monopterus cuchia* and used in the analysis of length-weight relationship in the species. The co-

efficient of correlation 'r' for the regression of total length and body weight were estimated to be 0.99, which is highly significant at 1 % level. However, a variation in 'b' value may occur due to different environmental factors.

Generally fishermen harvest cuchia throughout the year. The peak season of harvest is from November to March. During this time a fisherman could harvest up to 7 kg per day. During the off peak season the amount of harvest was 3.5kg per day. The figure 5 shows the average amount of cuchia caught in peak and off peak seasons in different Upazilas surveyed throughout the year. The method of harvest is traditional where the fishermen mainly use their hands to catch. Catching cuchia was necessitated special skill; the body of cuchia is highly slimy and can escape very easily. Cochin's holes had three openings and during, the fishermen keep one of the three holes closed with their one leg while the other two holes are entered with hands to catch. Sometimes catching is done by hooks or even by nets.

Some fishermen take it as a profession. They move from one place to another for harvesting cuchia. After harvesting, the catches were preserved in the earthen or plastic pot with water. There were no available references on the method of harvest of cuchia in Bangladesh or elsewhere in the world.

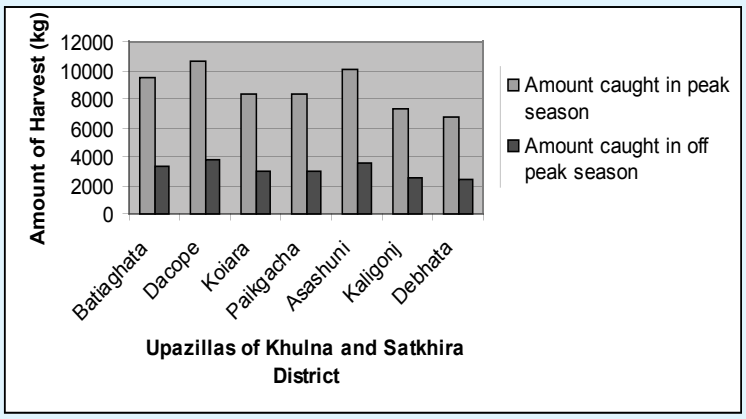

Figure 3. Amount of cuchia caught in peak and off peak season in different Upazilas throughout the year

Dhaka fish landing market is one of the largest places where sometimes cuchia specimens are marketed (Anon, 1996). Marketing of cuchia was found to be traditional and limited in the area, in general. Usually the middlemen use to buy the catch from the houses of the fishermen. Sometimes the fishermen themselves take the catches to the nearby market for selling. Generally the live specimens are marketed by keeping alive in earthen pots. During peak season cuchia is sold at Tk. 30-40/kg when there were more supply in the market, however, during off peak season the price is little higher and is sold at Tk. 40-50/kg. Among the six Upazillas surveyed, the best known places for marketing of cuchia were Kapilmoni, Koyra, Chalna and Paikgacha markets. It was not known if the harvests are marketed outside to different parts of the country.

Cuchia is a nonconventional fishery species in the country; is on rapid decline of abundance from the country. The species was not reported from semi-saline waters of Bangladesh. The study on the biology and fishery of the species revealed that large number poor low castes Hindus are engaged in fishing of cuchia in south-west Bangladesh for livelihoods. The present survey was made in Botiaghata, Dacope, Koira, Paikgacha of Khulna district and Kaligonj, Ashasuni, Debhata of Satkhira district.

There is not a wide range of consumers of cuchia. There were mainly two types of consumers. The low caste Hindus is the principal group eating cuchia. It was reported that often people from other castes take it as a convalescing food. Other than use as food for humans, cuchia is used as bait for catching crabs in the Sundarbans area. Every year the demand for cuchia was reported to increase in the area both for food and for use as bait. There is good market for the fish in carb fattening activities in the region.

Conclusion

The study was conducted in an area which has come out as one of the promising area of cuchia fishery in the country- the South-western coastal area. The environmental and the other conditions were suitable for this species. It has market value for food and for other uses. A number of fishermen from the low caste Hindus were involved in catching cuchia from the shrimp ghers in Khulna and Satkhira areas; the ghers after the harvest of aman paddy remain fallow during November

onward. The salinity of the water at that time is not that high and most harvesting of cuchia takes place at this time. There was a marketing system in the area; there were groups of middlemen who purchased the harvests from the houses of the fishermen; the harvests were marketed alive by keeping in earthen pots or the fishermen often took the catches to the nearby markets to sell. Cuchia have good international market and its socio-economic role in the area, more knowledge on the biology and fishery of the species should be known. The fish should be protected and conserved for sustainable management.

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Fish diversity and livelihood patterns of the fishers of Turag River, Bangladesh

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Abstract
An investigation was carried out from September, 2012 to August, 2013 to assess the fish diversity and livelihood pattern of fishers of the Turag River through the use of catch assessment survey, well structured questionnaire and participatory rural appraisal tools. A total of 48 species of fishes was recorded belonging to 21 families of10 orders were identified under 36 genus. Cypriniformes was most dominant order constituting 44% of the total fish population followed by Siluriformes (17%), Perciformes (15%),Channiformes (6%), Mastacembeliformes (4%), Osteoglossiformes (4%), Clupeiformes (4%), Beloniformes (2%),Tetraodontiformes (2%) and Decapoda (2%). Among all species 2 were critically endangered,7 were endangered, 6 were vulnerable and 23 species were not threatened recorded in the IUCN's red list of the country. The maximum number fish found 40 species in post-monsoon period. From assessing the present socio-economic status of fishing community the largest group of fishers belong to the age class 35-45 years(34%), followed by the age groups 25-35 (27%), 45-55 (17%), 15-25 (14%), and those older than 55 years (8%). Most of the fishers (54%) were illiterate. Only (27%) of them able to sign,14% fishers had primary level education and the only 5% fishers up to level eight and above group. About 16% of the fishers had low income (10,000 - 30,000 BDT), 58% had moderate income (30,000 - 60,000 BDT) and only 26% had high income (above 60,000 BDT). About 15% fishers had pit, 56% had ring slub and 29% had pacca sanitation system. Most of the 78% Fishers had 1-2 days meal per week with fish and only 22% had 3-4 days per week.

Key words: *Fish diversity, Livelihood, Turag River.*

Introduction

Bangladesh, the world largest deltaic region lies in the northeastern part of South Asia between 22° 34' and 26° 34' North latitude and 88° 1' and 92° 41' East longitude (Hussain, 2001). Due to its unique geo-physical location Bangladesh is exceptionally characterized by a rich biodiversity (Nishat et al.2002).The country abounds in large varieties of fish species that are 260 species of freshwater fish, 24 species that of prawns in inland water bodies and 442 species marine fishes, 36 species of marine shrimps and 18 species of exotic fishes (DOF, 2014).Fisheries sector plays an important role contributing 2.01% of the total export earning, 4.37% of the GDP and about 23.37% of the total agricultural production (DOF, 2014). The people of Bangladesh are provided with about 60% of total animal protein from fisheries sector. The country's total fish production has nearly doubled since 1999, reaching 3.410 million metric tons in the fiscal year 2012-2013 (DoF, 2014). The exported amount of the fish in the year of 2011-2012 was 84,905 metric tons, worth 4,312.61 Core Taka. The total area of the river and estuary of Bangladesh is about 46, 99,387 ha and contributing about 28, 21,266 metric tons of fish annually in the year of 2012-2013 (DoF, 2014).A large number of people earn their livelihood by catching fish in the Rivers. Additionally, these rivers provide spawning and nursery areas for different types of fish, amphibians, and reptiles, and a home for many wildlife species. The Turag River is the upper tributary of the Buriganga, partly encompass the capital city Dhaka. The river originates from the Bangshi River, the later an important tributary of the Dhaleshwari River flows through Gazipur and joins the Buriganga at Mirpur and the Tongi khal links the Turag with the Balu River (Choudhury and Choudhury 2004).

One of the most vulnerable communities in Bangladesh is fisherman who lives hand to mouth and they are considered as the poorest among the poor (Kabir et al. 2012).It was estimated that the average per capita annual income of the fisherman families about BDT 2,442 i.e. about 70% lower than the per capital income of the country as a whole. Being an isolated community fisherman are deprived of many amenities of life (Alam et al. 1995).The Turag River is one of the most important ecosystem with much cage aquaculture potential. Its flood fishery plays very important role in alleviation of rural poverty and supplying protein to the poor fishing community. However, socioeconomic status of this fisherman in the adjacent area of Turag River is not satisfactory and the production of fish in this river is also declining day by day. The current status of the fishes and the causes of the declination found out in the study are useful for taking conservation measures. Considering the above fact, the present study was carried out to assess the fish species diversity and livelihood patterns of the fishers of in the riverine area.

Material and Methods

The study was conducted from September 2012 to August 2013 of Gopinpur site located at Kaliakoir in Turag River. The Turag River flows closed to the Gazipur City, Geographical position of the study area Gopinpur lies between the 240 06 N to 900 16 E Latitude and longitude respectively(Fig. 1 & 2)).

Both primary and secondary data were used for present study. Primary data were collected through direct fish catch by the fishers in the river by using push net, seine net, cast net, lift net, gill net, hooks and long line and also structured questionnaire interview, focus group discussion (FGD) and cross-check interviews from fishers and local people. Some information gathered from Upazila Fisheries Officer, community leader, and NGO's staff. Questionnaire survey is an important part for collecting primary data. In conformity with the objectives of the study, a draft questionnaire was prepared in such a way that all factors associated with the socio-economic condition of fishers as well as concerning fish diversity could be covered. The draft questionnaire was pre-tested using elicit responses from interviewing several fishers. About 50 fishers were randomly selected to conduct this study. In addition, the secondary data were collected from, BWDB, WFC and reports, journals together with publication of IPAC, NSP, MACH, IUCN, DoF, Government of Bangladesh projects, etc.. The data obtained from questionnaires as well as reports was subjected to descriptive statistical analysis in form of frequencies and percentages by using SPSS V 20.0 developed by SPSS (mac) and MS Office Excel 2010 software's developed by the Microsoft Corporation.

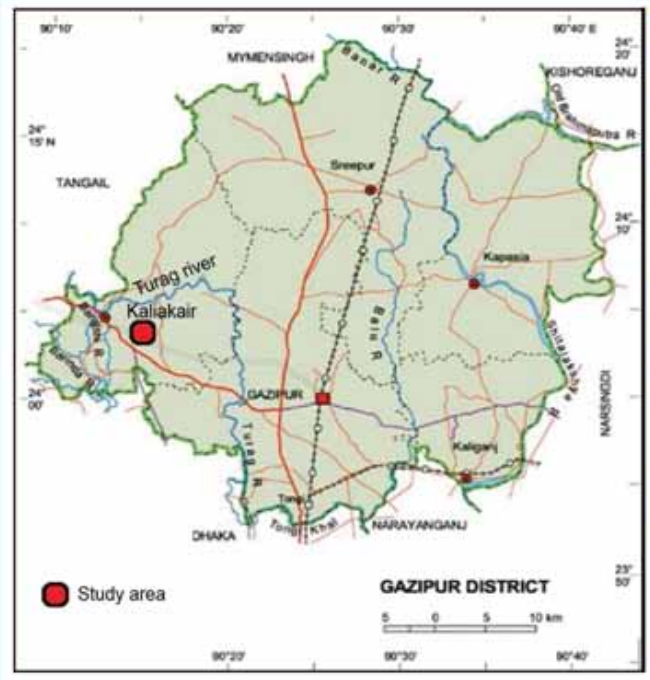

Fig 1. Map of Gazipur District Showing the Turag River including study sites.
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Fig 2. Map of Bangladesh Showing the study area.
www.nationsonline.org

Results and Discussion

A total of 48 species of fishes belonging to 21 families of 10 orders were identified under 36 genera. A checklist of identified fishes including their local names, abundance and status in Bangladesh are given in (Table 1).

Table 1. Fish fauna of Turag River with their status

Order	Family	Scientific Name	English Name	Local Name	Abundance	Status
Cypriniformes	Cyprinidae	*Labeo rohita* (Hamilton,1822)	Roho labeo	Rui	F	NT
		Labeo gonius (Hamilton,1822)	Kuria labeo	Goinna	R	EN
		Labeo calbasu (Hamilton,1822)	Orange fin labeo	Calbaus	F	EN
		Catla catla (Hamilton,1822)	Catla	Catla	R	NT
		Amblypharyngodon microlepis (Bleeker,1853)	Indian carplet	Dhela	C	NT
		Amblypharyngodon mola (Hamilton,1822)	Mola carplet	Mola	VC	NT
		Aspidoparia morar (Hamilton, 1822)	Aspidoparia	Morari	C	NT
		Cyprinus carpio (Linnaeus,1758)	Common carp	Mirror carp	R	TY
		Aristichthys nobilis (Richardson,1844)	Bighead carp	Bighead Carp	C	TY
		Ctenopharyngodon idella (Valenciennes,1844)	grass carp	Grass Carp	C	TY
		Hypophthalmicthys molitrix (Valenciennes,1844)	Silver carp	Silver Carp	F	TY
		Cirrhinus cirrhosus (Bloch, 1795)	Mrigal carp	Mrigal	F	NT
		Cirrhinus reba (Hamilton,1822)	Reba	Tatkini	VR	VU
		Puntius gelius (Hamilton,1822)	Golden dwarf barb	Jhilipunti	C	DD
		Puntius ticto (Hamilton,1822)	Ticto barb	Tit punti	R	VU
		Puntius chola (Hamilton,1822)	Swamp barb	Chalapunti	C	NT
		Puntius guganio (Hamilton,1822)	Glass barb	Molapunti	R	NT
		Puntius sarana (Hamilton,1822)	Olive barb	Sarpunti	R	CR
		Puntius conchonius (Hamilton, 1822)	Rosy barb	Kanchonpunti	C	NT
		Puntius sophore (Hamilton,1822)	Pool barb	Jatpunti	VC	NT
	Cobitidae	*Lepidocephalicthys guntea* (Hamilton, 1822)	Guntea loach	Gutum	VC	NL
Siluriformes	Bagridae	*Batasio batasio* (Hamilton,1822)	Tistabatasio	Tengra	F	EN
		Mystus bleekeri (Day,1877)	Day's mystus	Gulshatengra	C	NT
		Sperata aor (Hamilton,1822)	Long whiskered catfish	Ayre	VR	VU
	Clariidae	*Clarias batrachus* (Linnaeus,1758)	Walking catfish	Magur	R	NT
	Siluridae	*Wallogo attu* (Schneider ,1801)	Freshwater shark	Boal	VR	NT
	Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1794)	Stinging catfish	Shing	VC	NT
	Schilbeidae	*Silonia silondia* (Hamilton,1822)	Silond catfish	Shilong	VR	EN
		Eutropiicthys vacha (Hamilton,1822)	Batchwa vacha	Bacha	VR	CR

Perciformes	Anabantidae	*Anabus testudineus* (Bloch, 1795)	Climbing perch	Koi	R	NT
	Cichlidae	*Oreochromis mossambicus* (Peters, 1852)	Tilapia	Tilapia	VR	TY
	Nandiae	*Nandus nandus* (Hamilton,1822)	Mottled nandus	Meni	C	VU
	Osphronemidae	*Colisa fasciata* (Bloch and schneider, 1801)	Stripled gourami	Khailsha	VC	NT
	Leiognathidae	*Leiognathus equulus* (Forsskal,1775)	Common ponyfish	Lomba	R	NE
	Ambassidae	*Chanda nama* (Hamilton,1822)	Elongate glass perchlet	Nama chanda	C	VU
	Mugilidae	*Rhinomugil corsula* (Hamilton,1822)	Corsula mullet	Bata	R	NT
Mastacembeliformes	Mastacembelidae	*Macrognathus aculeatus* (Bloch, 1786)	Lesser spiny eel	Tarabain	VC	TY
		Mastacembelus armatus (Lacepede, 1800)	Tire track spiny eel	Baim	C	EN
Channiformes	Channidae	*Channa striatus* (Bloch, 1793)	Snakehead murrel	Shol	VR	NT
		Channa punctatus (Bloch, 1793)	Spotted snakehead	Taki	R	NT
		Channa marulius (Hamilton,1822)	Giant snakehead	Gajar	R	EN
Beloniformes	Belonidae	*Xenentodon cancila* (Hamilton,1822)	Freshwater garfish	Kakila	C	NT
Clupeiformes	Engraulidae	*Gudusia chapra* (Hamilton,1822)	Indian river shad	Chapila	C	NT
		Setipinna phasa (Hamilton,1822)	Gangetic hairfin anchovy	Phasa	F	NT
Osteoglossiformes	Notopteridae	*Chitala chitala* (Hamilton,1822)	Clown knifefish	Chital	R	EN
		Notopterus notopterus (Pallas,1769)	Grey featherback	Foli	VR	VU
Tetradontiformes	Tetradontidae	*Tetraodon cutcutia* (Hamilton,1822)	Ocellated pufferfish	Potka	F	NT
Decapoda	Paleomonidae	*Nematopalaemon tenuipes* (Handerson,1893)	Spider prawn	Guralcha	C	TY

But, MACH (2007) noted that from 1999- 2007, the fish species diversity varies from 81-91 species from their yearly record in the concerned River. The last three years (2010, 2011, 2012) record by IPAC showing 51 species. Hossain et al. (2012) recorded 53 species in Meghna River. Galib et al. (2013) recorded that a total 63 species of fishes belonging to 41 genera, 23 families and 9 orders in Choto Jamuna River, which was similar to the present study.

Cypriniformes was most dominant order constituting 44% of the total fish population followed by Siluriformes (17%), Perciformes (15%), Channiformes (6%), Mastacembeliformes (4%), Osteoglossiformes (4%), Clupeiformes (4%), Beloniformes (2%), Tetraodontiformes (2%) and Decapoda (2%). Galib et al. (2013) shown that the dominant order was Cypriniformes comprising 34.92% of all the number of species recorded. Next to Cypriniformes, other dominant orders were Siluriformes, Perciformes and Synbranchiformes constituting 28.57, 19.05 and 6.35% of species recorded, respectively in Choto Jamuna River. This was similar with the present study.

The dominant family was Cyprinidae comprising 42% of the total number of species caught. Other diversified families were Bagridae (6% species), Channidae (6%) and Anabantidae, Mastacemlidae, Notopteridae (4% species each) (Fig 3.).Galib et al. (2013) observed that the dominant family was Cyprinidae comprising28.57% of the total number of species caught. Other diversified families were Bagridae (9.52% species), Cobitidae, Channidae and Schilbeidae (6.35% species each) in Choto Jamuna River which was similar with the present study.

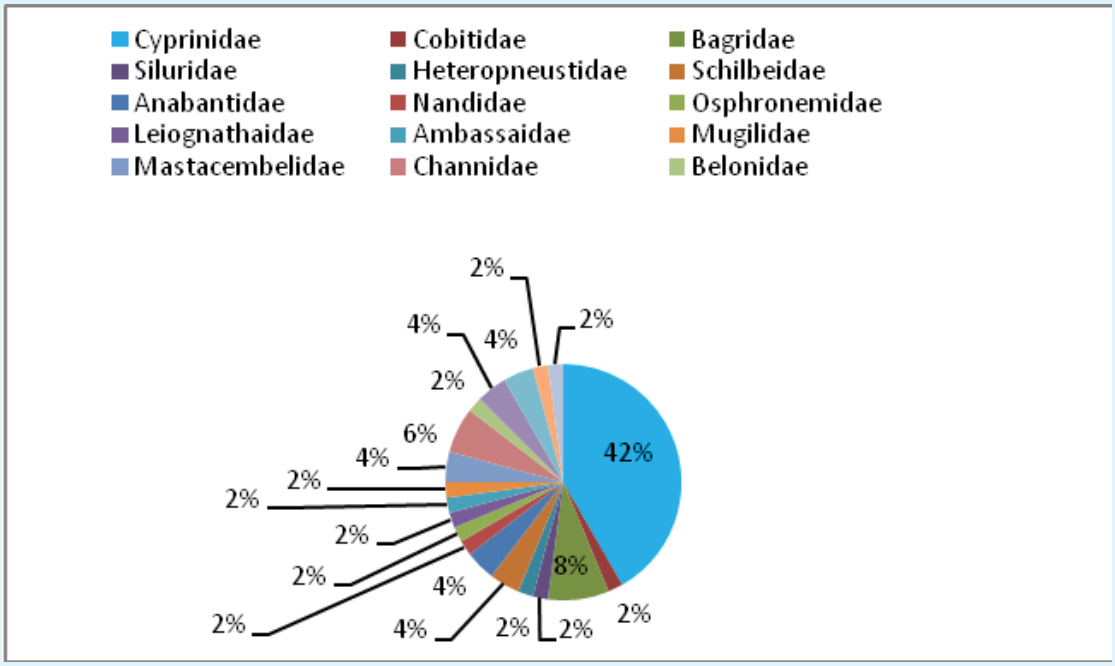


Fig 3. Family based percentage of fish species in Turag River

There was a significant variation of fish number and diversity in different months and seasons. In case of months, October, November, December and January showed significant dissimilarity with February and March. Maximum numbers of 40 species of fishes were found in post-monsoon period and minimum numbers of fish (13 species) were found in monsoon period. Maximum pH 8.2 is and minimum pH 7.2 is observed in Gopinpur. The maximum temperature was recorded in April as 29 °C and the minimum temperature was recorded in January as 17.5 °C.

The livelihood of the fishers shows that the 10% female and 90% male fishers whether most of the respondent (98%) was married (98%), 90% fishers were Hindu and rest were Muslim. The study also found that in Gopinpur the largest age class was 35-45 years old (34%), followed by 15-25 (14%), 25-35 (27%),35-55 (17%) and Above 55 (8%) (Fig 4.). Paulet al. (2013) reported that, age group of 35-40 years old was the highest 30% in Birulia whereas in Boroibari the largest age class was 40-45 years old (56%). Hossain et al. (2009) reported that age structure of fishers at Rajshahi district was ranged from 31-40 years (36.7%) which was similar with present study.

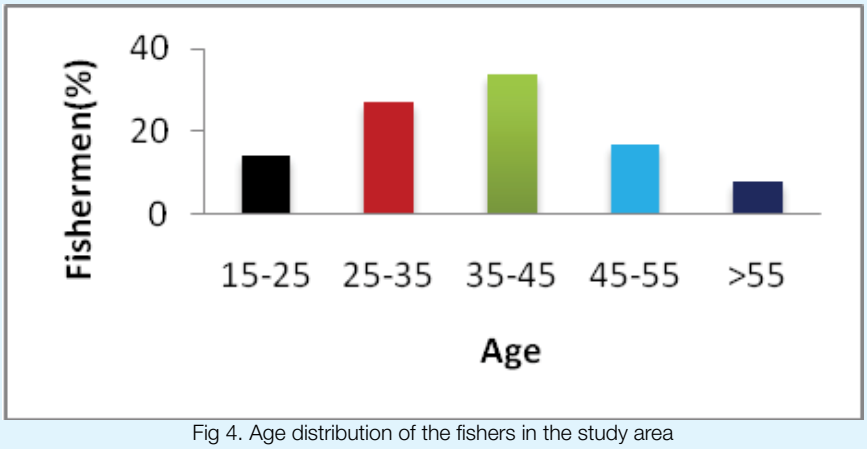


Fig 4. Age distribution of the fishers in the study area

Only 2% fishers in Gopinpur caught 6-8 kg fish daily, Most of the fishers 38% caught 3-4 kg per day, 4-5 kg caught 28% fishers, 2-3 kg caught 32% fishers (Fig 5).

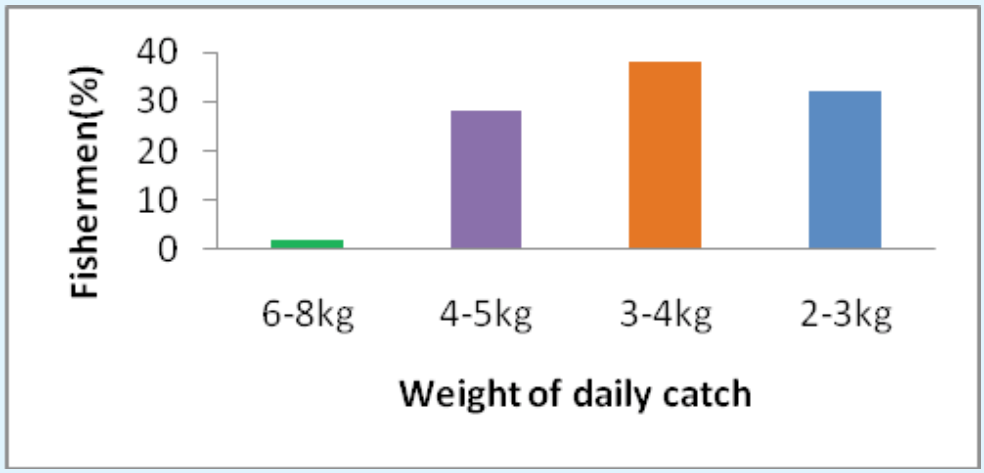
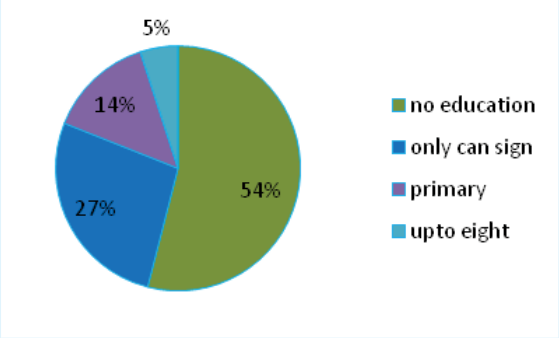


Fig 5. Daily catch of the fishers in the study area

Literature rate of the study area reveals that (27%) able to sign and illterate (54%), (14%) fishers had education up to primary level and (5%) up to eight level in Gopinpur village (Fig 6.).Paul et al. (2013) reported that most of the fishers of the study area were illiterate (46% in Birulia and 48% in Boroibari), able to sign (32% in Birulia and 34% in Boroibari village) and had education up to primary level (18% in Birulia and 16% in Boroibari). Rahman et al. (2012) also reported on the fishers of Nijhum Dwip that 66.66% fishers were illiterate while 16.66% had primary education and another 66.66% can sign only. The scenario of educational level of fishers is not satisfactory



It was observed that, fishers sanitation condition in the study area were poor. 15% Fishers in Gopinpur had pit, 56% Fishers in Gopinpur had ring-slub and 29% Fishers in Gopinpur had pacca sanitation (Fig 7.) system which were relatively satisfactory like fishers in Mymensingh district where Ali et al. (2009) in his study found that 62.5% of the farmers had semi-pucca, 25% had Kancha and 12.5% had Pucca toilet.

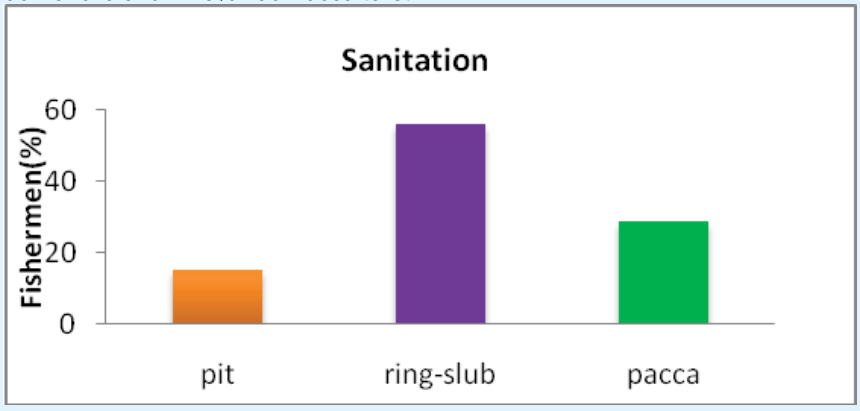


Fig 7. Sanitary facilities of the fishermen in the study area

About 70% Fishers in Gopinpur was full-time fishers. About 26% Fishers in Gopinpur was part-time fishers. Among part-time fishers, many of them engaged in agriculture and day labour activities, Women are mostly engaged in cloth making, rearing livestock etc. Kabir et al. (2012) Revealed that, 70% of fishers were engaged in fishing as their main occupation, 20% was in agriculture and 10% in daily labour as in sand business in old Brahmaputra river site. Siddiq et al. (2013) reported that a total 24.04% fisherman was professional, 13.46% fishers were seasonal, and the rest 62.5% fishers were subsistence at Dogger beel in Hajigonj Upazila, Chandpur District which was similar with the present study.

A better understanding of the state of the livelihoods of fishers, their daily income is the most important factor. About 58% fishers in Gopinpur had a moderate annual income (30000-60000 BDT). About 26% fishers in Gopinpur had a high annual income (above 60000 BDT). And only 16% fishers in Gopinpur had low income (10000-30000 BDT) (Fig 8.). Almost all fish they catch were sold by them. Paul et al. (2013) reported that about 63% fishers in Birulia and 35% in Boroibari had a moderate annual income (30000-60000 BDT). About 33% fishers in Birulia and 65% in Boroibari had a high annual income (above 60000 BDT) and only 4% fishers in Birulia had low income (10000-30000 BDT) in Turag River. Khan et al. (2013) reported similar result for Tista river fishers community like the present study.

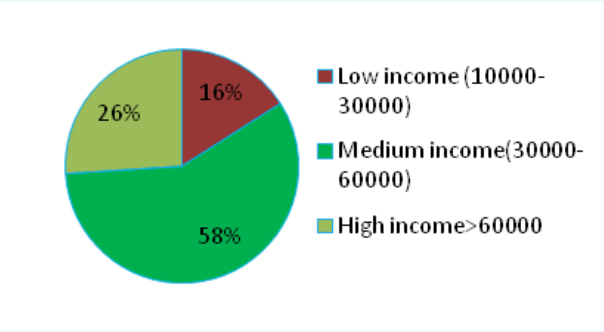


Fig 8. Annual income of the fishers in the study area

Most of the Fishers 78% in Gopinpur had 1-2 days meal with fish per week and 22% Fishers in Gopinpur had 3-4 days per week only.

The present investigation revealed that the diversity of fishes in the Turag river decrease day by day. Several factors as habitat destruction, water pollution, and overfishing, human intervention, misuse of gears and crafts, unplanned infra-structures, climate change are observed to be the causes of the degradation of species diversity. Also the socio economic condition of the fishers is not satisfactory. The fishers were deprived from many facilities. Long term studies on fish diversity, fishing gears and socio-economic condition are much essential to know the changes in the fish diversity and socio-economic development of the fishers community for better and sustainable Turag river management.

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Three new records of Butterfly from north-east region of Bangladesh

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Abstract
The present study was conducted in North-east Region of Bangladesh, from March 2012 to July 2013 with an aim to contribute and update the checklist of butterfly of Bangladesh. Three butterfly species were added to the known fauna of Bangladesh. These are *Graphium megarus* Westwood 1844 (Spotted Zebra) *Mooreana trichoneura* Felder & Felder, 1860 (Yellow Flat) from Adampur beat and Patharia Hill Reserve, whereas *Arhopala paraganesa zephyretta* Doherty, 1891 (Dusky Bushblue) was recorded from Lawachara National Park.

Key words: *Butterfly, New record, North-east Region, Bangladesh*

Introduction
The complete annotations of the butterflies of Bangladesh are yet to be completed (Khan 1982). The first comprehensive approach to document the butterflies of Bangladesh was performed by IUCN in 2004 when 311 species were recorded (Larcen 2004). Out of the 311 species, 236 were observed by Torben B. Larsen and the remaining 75 butterfly species were reported on the basis of records by previous researchers (Alam 1962a, 1962b, Ameen and Chowdhury 1968, Begum and Begum 1986, Alam and Ullah 1995). However, the record of 311 butterfly species were not the complete checklist and it is predicted that Bangladesh contains 500-550 species. To document unreported species, exploration has been continued and several researchers have reported new species records to update the checklist. In 2013-14, 12 species were added to the checklist by Hossain M et al, Neogi AK et al, Khan MK and Shahadat et al that increased the number of known species to 323 species (Khandaker et al. 2013, Neogi et al. 2014, Khan 2014, Shahadat et al. 2014). Nevertheless, it is still not a comprehensive checklist and it is believed that many butterfly species are yet to be recorded from Bangladesh.

One of the remarkable hotspot regions with diversified floral and faunal zone of Bangladesh is the North-east Region. This region is administratively under Sylhet division that consists of four districts and covers more than 12636 square kilometers and surrounded by the Indian states Meghalaya, Tripura and Assam. The North-east Region contains three National Parks, i.e. Lawachara National Park, Satchari National Park and Khadimnagor National Park. Besides the National Parks there are three eco parks, Madhabkunda Eco-Park, Tilagar Eco-Park and Borshijora Eco-Park and, one wildlife sanctuary named Rema-Kalenga Wildlife Sanctuary. The present survey of butterfly species was carried out in Rajkandi Reserve Forest (24° 24' 39.2" N and 91° 90' 58.2") E (Muzaffar et al. 2010), Lawachara National Park (24° 20' 29.02" N and 91° 47' 52.02" E) and Madhabkunda Eco-Park (24° 36' 40.16" N and 92° 17' 15.61" E). Present study is the first approach to annotate the butterfly species of the area.

Materials and Methods

Study area
Rajkandi Reserve Forest: Rajkandi Reserve Forest is located in the Moulvibazar district which lies in the north east region of Bangladesh (Chowdhury and Hossain 2013). The forest covers a large area of over 10000 hector (App) and divided into Adampur beat, Khurma beat and Kamarchara beat. The major plants species of the forest are *Dipterocarpus sp*. *Alangium agallocha, Artocarpus chaplasha, Anthocephalus chinensis, Tectonagrandis, Lagerstroemia parviflora, Ardisia solanacea, Hibiscus macrophylus, Antidesmaghasembilla, Syzygiumgrandis, Ficus religiosa, Ficus benghalensis, Ficus glaberrima, various species of Bambusa, Coccinea cordifolia, Eupatorium odoratum, Heliotropium indicumetc* (Muzaffar et al. 2010).

Lawachara National Park: Lawachara National Park (24° 30' 24.32" N and 91° 37' 91.39" E) is one of the 17 national parks of Bangladesh situated 60 kilometers southeast to Sylhet. This belongs to west Vanugach hill reserve. The park covers approximately 1250 hectors of semi and mixed evergreen forest. Till date 160 butterfly species have been recorded from LNP and it is known to have the richest butterfly diversity in Bangladesh.

Madhabkunda Eco-Park: Madhabkunda Eco-Park is one of three eco-park of the northeast region situated 70 kilometers north of the Moulvibazar district. This belongs to Patharia Hill Reserve. The eco-park comprises an area of over 265.68 hectares.

Specimen Identification

The butterflies were recorded from the study area during the butterfly survey from March 2012 to July 2013. The specimens were photographed using Canon 7D camera with Cannon 300 prime lens. Collection and killing of the specimen were avoided. The specimens were identified with the available keys (Chowdhury and Hossain 2013, Marshall and de Niceville 1883, Bingham 1905ab, Evans 1932, Wynter-Blyth 1957, Talbot 1978).

Results and Discussion

The recorded new species are *Graphium megarus* Westwood 1844 (Spotted Zebra), *Arhopala paraganesa zephyretta* Doherty, 1891 (Dusky Bushblue), *Mooreana trichoneura* Felder & Felder, 1860 (Yellow Flat).

Graphium megarus Westwood 1844 (Spotted Zebra)
Family: Papilionidae
Sub-family: Papilioninae

Graphium megarus Westwood 1844 (Spotted Zebra) (fig 1) was recorded for the first time from Bangladesh on March 30, 2013 from the Adampur beat of Rajkandi Reserve Forest. *Graphium megarus* Westwood 1844 was previously recorded from India (Arunachal Pradesh and Meghalaya). The discovery of the specimen from Rajkandi Reserve Forest extends its distribution from Arunachal to further north Moulvibazar, Bangladesh.

Fig 1: Upper side view of *Graphium megarus* Westwood 1844 (Spotted Zebra)

Mooreana trichoneura Felder &Feler, 1860 (Yellow Flat)
Family: Hesperiidae
Sub-family: Pyrginae

The *Mooreana trichoneura* Felder & Felder, 1860 (yellow flat) (Fig 2) was observed first time from the Adampur beat of Rajkandi Reserve Forest on 5th June, 2012. From our later expedition of the region we have sighted the specimen from the same area on 10th December, 2013 and from Madhabkunda Eco-Park on 14th March, 2013. The butterfly was perching on a leaf when it was photographed. It indicates this Butterfly is distributed throughout whole north-east area of Bangladesh. Our observation it mainly occurs in flowing stream area of broad leaved evergreen forests. The butterfly was previously recorded from India (West Bengal, Meghalaya, Tripura) Thailand, Philippine, Malaysia to Singapore. Present record confirms its presence in Bangladesh also.

Fig 2: Upper side view of *Mooreana trichoneura* Felder & Felder, 1860 (Yellow Flat)

Arhopala paraganesa zephyretta Doherty, 1891 (Dusky Bushblue)
Family: Lycaenidae
Sub-family: Theclinae

The *Arhopala paraganesa zephyretta* Doherty, 1891 (Dusky Bushblue) (Fig 3) was recorded on April 14, 2013 from Lawachara National Park. It occurs in the dense bushy undergrowth of the forest. The butterfly was previously recorded from India (Assam) and Thailand. The current record extends its habitat to Bangladesh also.

Fig 3: Upper side view of *Arhopala paraganesa zephyretta* Doherty, 1891 (Dusky Bushblue)

Conclusion

The present study with the discovery of the three new butterflies from North-east region of Bangladesh implies the richness of the biodiversity of the forest and signifies the importance and need for more extensive survey in that region. Inclusion of these three new species extends the number of butterfly species recorded in Bangladesh to 323. Nevertheless, the checklist is not complete and there are many undiscovered species waiting to be recorded. So, in future exploration should be continued to annotate new species and to update the status and distribution of the butterfly fauna of Bangladesh.

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DNA Barcoding: Challenge and opportunities for vertebrate faunal diversity and conservation in Bangladesh

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Abstract
Bangladesh having an area of 147,570 square kilometres (sqkm) contains 251 inland fishes, 402 marine fishes, 34 amphibians, 126 inland reptiles, 17 marine reptiles, 388 resident birds, 300 migratory birds, 110 inland mammals and 03 marine mammals. This is really an extraordinary situation that such a great diversity still exists in an unusually overpopulated country. Unfortunately, there is no stock taking and regular monitoring system exists for this invaluable resources. The review of the status of the vertebrate fauna revealed that 54 inland fishes, 08 amphibians 58 inland reptiles, 41 resident birds and 40 inland mammals have come under different categories of threat in Bangladesh (IUCN, 2000). The country has already lost more than 12 vertebrate fauna during the last century. The lack of proper database on our biodiversity is one of the greatest impediments for utilization and safeguarding of our interests. DNA barcoding is an efficient tool for flagging potential new and cryptic species identification. The work has been started at the Department of Zoology, University of Dhaka, initially with freshwater fishes and so far some 30 species have barcoded. The country now needs to maintain the genetic identity establishing a reference library of barcodes from identified voucher specimens as well as integrity of species in their natural habitats. Hence, documentation of genetic variation and diversity is of vital significance to evolve conservation strategies with long term impact.

Introduction
Biodiversity is the degree of variation of life forms within a given species, ecosystem, biome, or planet. The period since the emergence of humans has displayed an ongoing biodiversity reduction and an accompanying loss of genetic diversity. The 1992 United Nations Earth Summit defined "biological diversity" as "the variability among living organisms from all sources, including, 'inter alia', terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (Hawksworth, 1996). This definition is used in the United Nations Convention on Biological Diversity. "Biodiversity" is most commonly used to replace the more clearly defined and long established terms, species diversity and species richness. Biologists most often define biodiversity as the "totality of genes, species, and ecosystems of a region". An advantage of this definition is that it seems to describe most circumstances and presents a unified view of the traditional three levels at which biological variety has been identified as species diversity, ecosystem diversity and genetic diversity.

Species Diversity: Refers to the frequency and diversity of different species within a geographic area or an ecosystem, such as *Tenualosa ilisha*.

Ecosystem Diversity: Refers to variety and frequency of different ecosystems. An ecosystem is a dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit, such as the forest ecosystem, the wetland ecosystem.

Genetic Diversity: The level of biodiversity, refers to the total number of genetic characteristics in the genetic makeup of a species. It is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary. A study conducted by the National Science Foundation (2007) found that genetic diversity and biodiversity are dependent upon each other—that diversity within a species is necessary to maintain diversity among species, and vice versa.

Taxonomy
Taxonomy is the science of the description and classification of organisms, essential in theoretical and applied biology. About 8.7 million (±1.3 million SE) eukaryotic species globally, of which ~2.2 million (±0.18 million SE) are marine. In spite of 250 years of taxonomic classification and over 1.2 million species already catalogued in a central database. It is suggested that some 86% of existing species on Earth and 91% of species in the Ocean still await description. Renewed interest in further exploration and taxonomy is required if this significant gap in our knowledge of life on Earth is to be closed.

Tools of Taxonomy

The taxonomist uses several characteristics or identification parameters. These can be divided in four main groups: i. The appearance and position of body structures, e.g., lateral line, scales, colorations, etc. ii. Parameters that can be measured, e.g. standard length, eye diameter, etc.; iii. Anatomical parts that can be counted, e.g., Fin rays, spines, teeth, etc. and iv. Molecular genetic markers, e.g., allozyme, mt DNA, DNA sequence (COI gene).

Molecular genetic markers

Molecular genetic markers are powerful tools to detect genetic uniqueness of individuals, populations or species. These markers have revolutionized the analytical power, necessary to explore the genetic diversity. The conclusion from genetic diversity data has varied application in research on evolution, conservation and management of natural resources and genetic improvement programs, etc. (Hajibabaei et al., 2007). In addition to protein markers, application of DNA markers is finding wide acceptance in population genetics. With DNA markers, it is theoretically possible to observe and exploit genetic variation in the entire genome. Both genomic and mitochondrial DNA is used for varied applications. The commonly used technique are allozyme analysis, types of restriction fragment length polymorphism (RFLP), randomly amplified polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP), microsatellite typing, single nucleotide polymorphism (SNP), and expressed sequence tag (EST) markers, etc. Molecular markers can be classified into type I and type II markers. Type I markers are associated with genes of known function, while type II markers are associated with anonymous genomic regions. Under this classification, allozyme markers are type I markers because the protein they encode has known function. RAPD markers are type II markers because RAPD bands are amplified from anonymous genomic regions via the polymerase chain reaction (PCR). In general, type II markers such as RAPDs, microsatellites, and AFLPs are considered non-coding and therefore selectively neutral. Such markers have found widespread use in population genetic studies to characterize genetic divergence within and among the populations or species.

Mitochondrial DNA Markers

Mitochondrial DNA (mtDNA) analysis is being increasingly used in recent population and phylogenetic surveys of organisms. Studies of vertebrate species generally have shown that sequence divergence accumulates more rapidly in mitochondrial than in nuclear DNA. This has been attributed to a faster mutation rate in mtDNA that may result from a lack of repair mechanisms during replication and smaller effective population size due to the strict maternal inheritance of the haploid mitochondrial genome. Due to its rapid rate of evolution, mtDNA analysis has proven useful in clarifying relationships among closely related species. Different parts of the mitochondrial genome are known to evolve at different rates. Almost the entire mtDNA molecule is transcribed except for the approximately 1-kb control region (D-loop), where replication and transcription of the molecule is initiated. In general, non-coding segments like the D-loop exhibit elevated levels of variation relative to coding sequences such as the cytochrome b gene, presumably due to reduced functional constraints and relaxed selection pressure. The 16S rRNA gene in the mitochondrial genome is one of the slowest evolving genes whereas rapidly evolving regions are control regions. Due to non-Mendelian mode of inheritance, the mtDNA molecule is considered as a single locus. In addition, because mtDNA is maternally inherited, the phylogenies and population structures derived from mtDNA data may not reflect complete picture of the nuclear genome if gender-biased migration or selection or introgression exists. Analyses of mtDNA markers have been used extensively to investigate stock structure in a variety of vertebrates including fishes, birds, reptiles and mammals.

DNA Barcoding

DNA barcoding first came to the attention of the scientific community in 2003 when Paul Hebert's research group at the University of Guelph published a paper titled "Biological identifications through DNA barcodes". In it, they proposed a new system of species identification and discovery using a short section of DNA from a standardized region of the genome. That DNA sequence can be used to identify different species, in the same way a supermarket scanner uses the familiar black stripes of the UPC barcode to identify your purchases.

The gene region that is being used for almost all animal groups, a 648 base-pair region in the mitochondrial cytochrome c oxidase 1 gene ("CO1"), is proving highly effective in identifying birds, butterflies, fish, flies and many other animal groups. The advantage of using COI is that it is short enough to be sequenced quickly and cheaply yet long enough to identify variations among species.

Ever since Carl Linnaeus began systematically classifying all living things 250 years ago, bi-ologists have looked at various features—color, shape, even behavior—to identify animals and plants. In the past few decades, researchers have begun to apply the genetic information in DNA to the task. But both classical and modern genetic methods demand great expertise and eat up huge amounts of time. Using just a small section of the DNA—something more akin to the 12-digit barcode on products—would require far less time and skill.

Why we need Barcoding?

Morpho-taxonomy of plants and animals—has enabled scientists to designate some 1.2 million species, a remarkable feat, and morphology remains the foundation of Linnaean-type taxonomic diagnosis. The nuances that distinguish closely allied species are so complex that most taxonomists specialize in one group of closely related organisms. As a result, a multitude of taxonomic experts are needed to identify specimens from a single biodiversity survey. Finding appropriate experts and distributing specimens can be time-consuming and expensive. Web-based databases with high-resolution images help with the logistics to some extent, but other problems persist.

Such as, biologists estimate that some 7.5 million species have not yet been described, and as the encyclopedia of morphological characterizations expands, simply determining whether a specimen matches a known species will become increasingly difficult. Furthermore, eggs and juvenile forms, which are often more abundant than adults, may have no distinguishing characteristics and must be reared to maturity (if that is possible) to be identified. In some species, only one sex can be identified. A quick and easy standardized method of using genetic information could bridge these problems.

DNA Barcoding Process

Scientists were able to settle on a particular gene segment as the standard reference for animal species. This segment is part of a gene housed in mitochondria—energy-producing subunits of cells, which are inherited from the mother. The gene selected gives rise to an enzyme called cytochrome c oxidase subunit 1, or CO1 for short. The CO1 barcode region is small enough that the sequence of its nucleic acid base pairs (the “rungs” of the famous double helix) can be deciphered in one read with current technology. And although it is a tiny fraction of the DNA inside each cell, it captures enough variation to tell most species apart.

In primates, for example, each cell has about 3.5 billion base pairs. The CO1 barcode is only 648 base pairs long, yet examples taken from humans, chimpanzees and the other great apes harbor enough differences to distinguish the groups. Humans vary from one another at one or two base pairs in the barcode region, but we diverge from our closest relative, chimpanzees, at approximately 60 sites and from gorillas at about 70 sites (Stoeckle & Hebert, 2008).

Mitochondrial DNA proved especially suitable, because sequence differences among species are much more numerous than in the DNA of a cell’s nucleus. Thus, short segments of mitochondrial DNA are more likely to parse separate species. In addition, mitochondrial DNA is more abundant than nuclear DNA and therefore easier to recover, especially from small or partially degraded samples.

To prove that this small DNA tag could actually identify a species, scientists, along with their colleagues, have tested the effectiveness of the CO1 barcode in diverse animal groups from land and sea, from the poles to the tropics. It was found that CO1 barcodes by themselves distinguish about 98 percent of species recognized through previous taxonomic study. In the remainder, they narrow identification to pairs or small sets of closely allied species, generally lineages that only recently diverged or species that hybridize regularly.

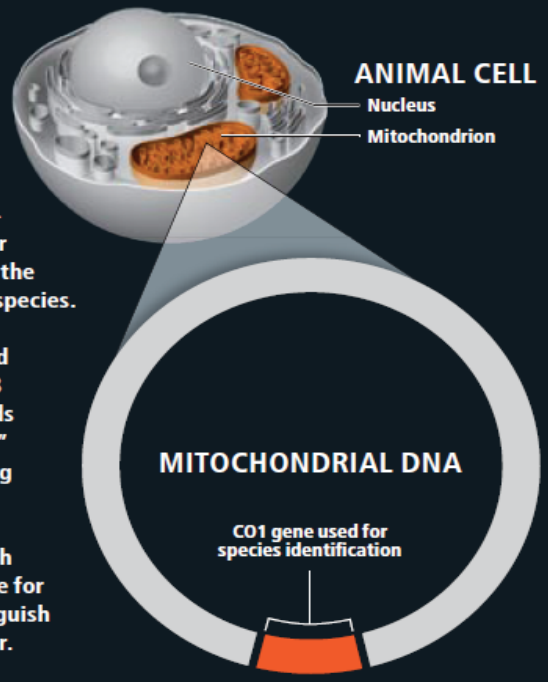
Now a barcode is found, the next step is to compile a reference library of this segment from specimens whose identity is already firmly established. By comparing barcode DNA from some creature against these “voucher specimens,” researchers can determine whether the organism is a member of a known species or is a new find. The mechanics of creating the library are simple: someone obtains DNA from a tissue sample, determines the base-pair sequence of the barcode segment, and enters the information into a barcode database. The acquisition of specimens is more complex. To aid construction of the barcode library, researchers at many institutions have begun assembling large tissue banks stored under conditions that preserve DNA. Keeping track of so many specimens and their sequences is an engineering challenge in itself.

But the process has already begun with the establishment of a public database called the Barcode of Life Data systems, or BOLD (online at www.barcodinglife.org). BOLD currently contains records for more than 149,434 species derived from well over millions specimens with particularly dense records for birds, fishes, butterflies and moths. Each of these records contains the species name, barcode sequence, collection location, and links to the voucher specimen, photographs and other biological data. To help coordinate the enormous effort involved in the assembly of such a comprehensive library, the Consortium for the Barcode of Life (CBOL) was established in 2005; it includes 150 institutions from 45 countries that support the development of DNA barcoding as a global standard for the identification of species. The actual assembly of records will be driven by the International Barcode of Life Project: a 25-nation alliance that plans to process five million specimens from 500,000 species by 2014 (Ward et al., 2009).

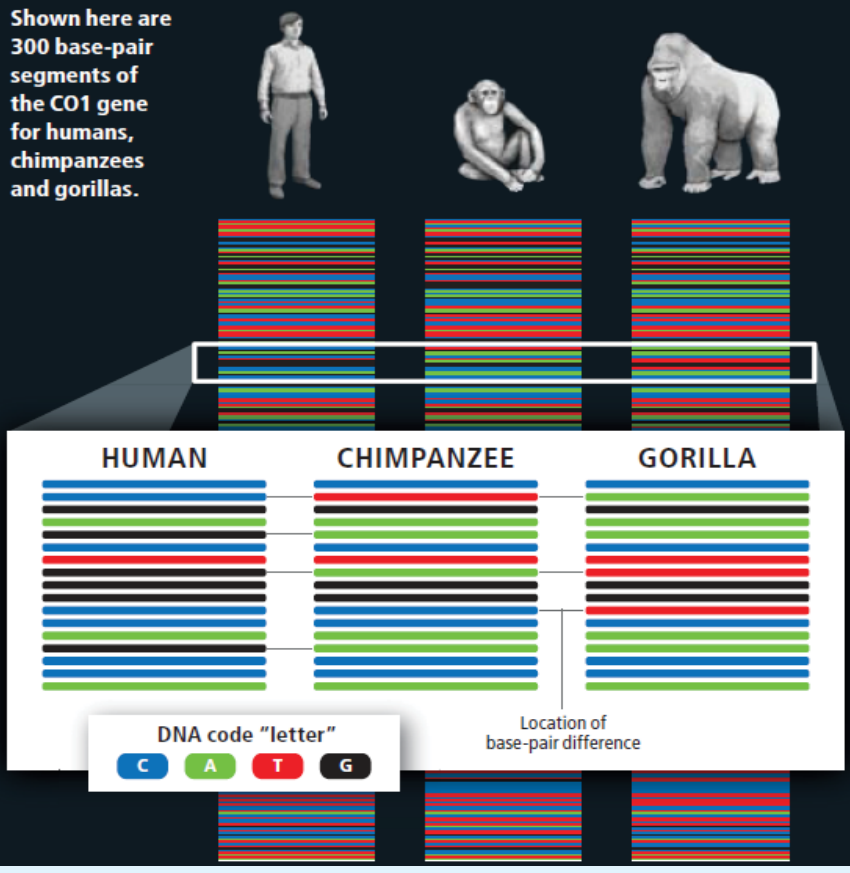
[HOW BARCODING WORKS]

STREAMLINED GENETICS

Each cell from an animal contains DNA in both the nucleus and the mitochondria. The authors and their colleagues selected a small segment of DNA from the mitochondria—the same short strand for each species—to use for the identification of animal species. The segment they chose comes from a gene called CO1. It contains only 648 base pairs of nucleic acids (essentially, the "letters" of the DNA code), making for quick reading of its DNA sequence. But the small piece varies enough from creature to creature for the differences to distinguish one species from another.



Shown here are 300 base-pair segments of the CO1 gene for humans, chimpanzees and gorillas.



Bangladesh perspectives

Bangladesh is part of the Indo-Burma region, which is one of the ten global hot-spot areas for biodiversity. Due to its unique geo-physical location and characteristics, Bangladesh is characterized by an exceptionally rich biological diversity and has approximately 113 species of mammals, more than 628 species of birds, 126 species of reptiles, 22 species of amphibians, 708 species of marine and freshwater fish, 2,493 species of insects, 19 species of mites, 164 species of algae (or seaweed) and 4 species of echinoderms. The country has many unidentified or misidentified fauna and moreover some cryptic species. DNA barcoding along with traditional morpho-taxonomy can solve this species dilemma more authentically.

Recently, IUCN Bangladesh is updating their red list species and it is obvious that the number of threatened species will increase over the last 14 years due over exploitation, illegal trade and habitat destruction. It is now prime importance to make an inventory/reference library of vertebrate fauna with their status of Bangladesh using DNA barcoding tool. At initial stage, we started DNA barcoding of freshwater fishes at the Department of Zoology, University of Dhaka and already barcoded some fishes. To complete our mission we need more local and international cooperation from the scientific and donor communities. The documentation of genetic variation and diversity of Bangladesh fauna will be the mile stone for the government, policy makers and mangers to undertake long term conservation and management strategies for biodiversity.

Table 1.Number and conservation status of inland and resident vertebrate species of Bangladesh

Group	Total No. of living species	Extinct	Threatened				Data deficient	Not Threatened (NO)
			Critically Endangered (CR)	Endangered (EN)	Vulnerable	Total		
Fishes	266	0	12	28	14	54	66	146
Amphibians	22	0	0	3	5	8	7	7
Reptiles	109	1	12	24	22	58	39	12
Birds	388	2	19	18	4	41	158	189
Mammals	110	10	21	13	6	40	53	17
Total	895	13	64	86	51	201	323	371

Source: IUCN, 2000

Conclusions

DNA barcoding is poised to contribute to taxonomic research and to population genetics and phylogenetics. In taxonomy, DNA bar-coding can be used for routine identification of specimens; and it can also flag atypical specimens for comprehensive taxonomic investigation. In phylogenetic studies, DNA barcoding can be a starting point for optimal selection of taxa, and barcode sequences can be added to the sequence dataset for phylogenetic analysis. In population genetics investigations, DNA barcodes can provide as a first signal of the extent and nature of population divergences and will facilitate comparative studies of population diversity in many species. On the basis of recent developments, we expect that the barcode databases will grow rapidly – some facilities are already processing >100000 specimens per year. Consequently, the International Nucleotide Sequence Database (INSD: GenBank, EMBL, and DDBJ) has adopted a unique keyword identifier (BARCODE) to recognize standard keyword identifier (BARCODE) to recognize standard barcode sequences specified by the scientific community(i.e. CBOL).DNA barcoding can speed up the survey of biodiversity. The fact remains, however, that formal descriptions of new species can take years to complete. The generation of sequence data is thus running far ahead of official species descriptions. We view barcoding as creating a map of DNA diversity that will serve as a framework for subsequent detailed study. Just as the speed and economy of aerial photography caused it to supplant ground surveys as the first line of land analysis, DNA barcoding can also be a rapid, relatively inexpensive first step in species discovery. The “ground trusting” will take more time. But linking these approaches will produce an integrated view of the history and present-day existence of life on earth and help to shepherd life’s full magnificence into the coming century.

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Assemblage of mammals and birds in response to fruiting phenology of *Ficus variegata* at Lawachara National Park, Bangladesh

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Abstract
Ficus species have been regarded as keystone resources for frugivores in tropical forests as well as in other habitats, especially for producing fruits when other fruit resources are relatively scarce. This study was conducted to evaluate the assemblage of birds and mammals in response to fruiting phenology of Ficusvariegata at Lawachara National Park between December 2009 and December 2010. A total of 13 mature fig trees covering different habitat subtype and disturbance were selected for systematic study out of 110 trees. Scan-sampling method with five minutes interval was followed for recording birds and mammals at the canopy of a fruiting tree. This study revealed Ficusvariegataas a deciduous tree species and fruits were available all the year round. Leaf production was highly seasonal and correlated with rainfall. Leaf shedding was strongly negatively correlated with rainfall (T = -0.68, P = 0.05). A higher proportion of individuals bore fruits during winter, December to February, and pre-monsoon, March to May. A total of seven mammalian species was found feeding on figs of this Ficus species which represents 35% of total mammalian species in the Lawachara National Park. Four globally threatened primate species included endangered Hoolock Gibbon (*Hoolock hoolock*) and Phayre's Leaf Monkey (*Trachypithecus phayrei*); vulnerable Capped Leaf Monkey (*Trachypithecus pileatus*) and Pig-tailed Macaque (*Macaca leonina*) consumed figs of *F. variegata*. Hoolock Gibbon was found to be the most frequent in this tree (29%) while Phayre's Leaf Monkey was least frequent (4%). Consumption of *F. variegata* figs by Rhesus Macaque (*Macaca mulatta*) only in winter showed evidence as a useful food resource during lean period of the year. No bird species consumed figs of *F. variegat*e though used for different purposes.

Key words*: Assemblage,Ficus Phenology*

Introduction
There are over 750 species of Ficus worldwide which belongs to the family Moraceae (Berg, 1989). Due to their year round fruiting phenology, Ficus species have been considered keystone resources for frugivores in tropical forests as well as in other habitats, especially for producing fruits when other fruit resources are relatively scarce (Terborgh 1986; Lambert and Marshall 1991; Kannan and James 1999; Ragusa-Netto 2002). A study recorded starving sun bears *Helarctos malayanus* and bearded pigs *Sus barbatus* during a period of unusually low production of fig fruit at Danum Valley in northeast Borneo (Wong et al, 2005).Surveys of vertebrate diets in both the New World and Old World show that around 1274 bird and mammal species feed on Ficus species (Shanahan and Compton, 2001). Frugivores are an important group of vertebrates in the tropics for the seed dispersal of a wide diversity of plant species. Tropical Asian forests are particularly rich in Ficus species, with about 60% of known world species (Harrison, 2005), while in Bangladesh there are 47 Ficus species have been recorded (Ahmed et al. 2009).

Biodiversity conservation is now global concern. Keystone resources like Ficus conservation can become one of the most effective tools in biodiversity conservation as it supports a great number of faunal diversity and help to regenerate forest. This study was the first attempting Bangladesh to provide baseline information on the phenology of *F. variegata and* assemblages of mammals and birds in the canopy when fruiting occur.

Methods
This study was conducted between December 2009 and December 2010 at the Lawachara National Park, Bangladesh. In total, 37 days were spent in the field of which 8 days were spent to study phenology, 3 days were spent for taking GPS coordination and 26 days were spent for animal observation. Scan-sampling method with five minutes interval was followed for recording mammals and birds at the canopy of a fruiting tree. A total of 13 mature fig trees were selected for systematic study out of 110 trees based on different habitat subtype and disturbance. *Ficus variegata* were identified by reference to botanical keys (Ahmed et al, 2009).The number of sample size (13) might seem statistically small. However, a significant number of studies were conducted with low sample size (Sreekaret al. 2010). Tree structure included tree height, bole height, Diameter at breast height (DBH), canopy width and position. Presence of epiphytes and orchids were also observed under tree structure. Crop size (number of fruits) was estimated by counting figs in one small part of a tree, and then multiplying by the total number of such small parts.

Table 1. Indices for leaf maturity and fig abundance for *F. variegata.*

Value	Crown position	Leaf maturity index	Fig abundance index
0	No contact	No leaves	No figs
1	1-25%	1-25%	1-25%
2	25-50%	25-50%	25-50%
3	50-75%	50-75%	50-75%
4	75-100% attached	75-100% crown surface contains leaf products either buds or new and mature leaves	75-100% crown surface contains figs either green or ripe

Results

Tree structure

Tree height varied from 12-40 m with a mean height of 25m (± 8.29m SD, n=14). A mean 212 cm DBH (± 44 cm SD, n=14) were measured which varied from 165-365 cm. Bole height of trees varied from 4-20 m and average bole was found at 11.39 m (±5 m SD, n=14).Crown volume of trees was medium to large size (median size =2919.4 m^3, range = 630-9350 m^3, n = 14) and 92.9% crowns were attached with neighboring tees. Mean crown spread was 15±2.7 m, n = 14. Crown diameter ranges from 9.5-19.5 m.

Leaf Phenology

F. variegata was found deciduous. Leafless condition of trees was highly seasonal, occurring chiefly during the winter season (Dec.-Feb.). Highest frequencies of leafless trees were found in February. The temporal leaf change sequence was characterized by leaf shedding until all leaves had fallen off and a new flush started. Buds were dominated the fig canopy in early pre-monsoon (March). However, leaf flushing sometimes overlapped leaf shedding. Young leaves were available throughout the study period. Mature leaves dominated the fig canopy during late pre-monsoon and early monsoon (April and May). Leaf shedding was highly seasonal. Percentages of leaf shedding were highest during winter and lowest in monsoon. Leaf shedding was absent in May. Leaf shedding negatively correlated with monthly rainfall.

Fruiting Phenology

Fruits were available all the times during study period and produced asynchronously within individual trees (Fig.1). A higher proportion of individuals bore fruits during winter, December to February, and pre-monsoon, March to May. During monsoon fig production was relatively low.

Relationships among phonological traits

Kendall rank correlations were used for the statistical analysis of relationships among categorical variable.

Table 2. Kendall rank correlation between Leaf shedding, Fig abundance, Crown volume, Crop size, DBH and rainfall.

X	Y	T	P value
Rainfall	Leaf shed	-0.687	0.05
Rainfall	Fig abundance	-0.72	0.05
DBH	Crown Volume	0.433	0.05
Crown Volume	Crop size	0.648	0.01
DBH	Average Crown Spread	0.384	0.05

Leaf shedding was significantly negatively correlated with rainfall (T= -.687; P =0.05). Fig abundance was strongly negatively correlated with monthly rainfall (T = -.720; P = 0.05). Crown volume is less moderately correlated with DBH (=. 433; P = 0.05) while crop size significantly correlated with crown volume (T= .648; P = 0.01). Average crown spread is weakly correlated with DBH (T = .348; P = 0.05).

Crop Size and fig measurement

Crop size of trees was large. A mean number of 20658 fig (±26182 SD, N=11) was found by direct count with a range of 1500-80,000. Mean diameter of fig was measured 28.51±3.99 mm, N=16. Maximum and minimum diameter was measured 42.01 and 24.55 mm respectively. Besides, mean length was measured 24.48±2.45 mm which ranged from 21.47 to 30.93 mm. An average of 27.69±2.64 mm (N=15) pedicel length was measured during the study while length ranged from 23.01-32.69 mm.

Assemblage of mammals and birds

Seven mammalian species, 35% of the total mammal species in Lawachara NP, were recorded in the tree with a total of 90 visits at the canopy during the study period. Guild comprised of one ape, four monkeys and two squirrel species for foraging figs on the tree. Four globally threatened primate species included endangered Hoolock Gibbon (*Hoolock hoolock*) and Phayre's Leaf Monkey (*Trachypithecus phayrei*); vulnerable Capped Leaf Monkey (*Trachypithecus pileatus*) and Pig-tailed Macaque (*Macaca leonina*) consumed figs of *F. variegata*. Two squirrel species, Hoary bellied Squirrel (*Callosciurus pygerythrus*) and Orange-bellied Himalayan Squirrel (*Dremomys lokriah*), also consumed the figs. The species accumulation curve had flattened off by seven-month observation period, suggesting all species that feed on the figs of *F. variegata* have seen (Fig. 2). However, Primates dominated in trees with 5 species and 61 visits compared to Squirrels (2 species and 29 visits). Hoolock gibbon was the most abundant, 26 visits (29%) followed by orange-bellied Himalayan squirrel visited trees 20 times (22%). Pig-tailed Macaque and Capped Leaf Monkey visited trees 14(16%) and 12(13%) times respectively. However, Pharey's Langur and Rhesus Macaque were sighted around trees in good numbers but seldom visited trees and recordings were made of these species feeding on figs during winter period. Though, Hoary-bellied squirrel was sighted in trees for only 9 times (10%), this species was available in all months. All the mammals feeding on figs visited trees more frequently during the winter season. Highest 28 visits (31%) were recorded in February which ranked top month followed by March (15 visits and 7%). During monsoon, they were less frequent in trees. In May and June, only 6 (7%) and 5 (6%) visits were recorded.

No bird consumed figs of *F. variegata*. Black Baza (*Aviceda leuphotes*) used the advantage of the height for searching prey items. Bar-winged Flycatcher Shrike (*Hemipus picatus*) and an unidentified warbler used for foraging and resting. Many swiftlets had seen flying on the sky above fig trees which feed on swarming larvae of fig wasps.

Discussion

Trees were found deciduous and bore fruits all the year round. Leaf production was seasonal and correlated with rainfall. Leaf shedding and fig production had negative correlation. Seven mammal species visited the tree when the fruit occurred in the canopy. No birds were observed to eat figs of the tree. Spencer et al. 1996 studied phenology of *F. variegate* at Cape Town, Australia. They reported the tree produce fig continually throughout the year and a deciduous species. Our result was supported by their findings of correlation between rainfall and leaf production, fig abundance, leaf maturity and had similar response. However, they observed figs were least abundant during the early dry period (June-September) and most abundant from the late dry season (October- November) through the wet season (December-April). Our result differed as we found fig production was most abundant in winter (December-February) and least in monsoon (June-August) perhaps due to the difference of seasonality and location of the two study sites. Feeroz (1999) found significant positive correlation between leaf production and monthly rainfall at the same study area.

Fig eating by primates has been well documented (Shanahan, 2001).Primates has also been well studied at our study site and fig consumption of *F. variegatais* well documented (Feeroz& Islam 1992;Kabir 2002; Hasan 2003; Atiquzzaman 2008).Our result showed at least four globally threatened primate species consumed figs of *F. variegata*. The importance of figs to squirrels has also been well documented (Payne, 1979). Two *Callosciurus* species were seen to eat figs of *F. variegata* at Lawachara but *R. bicolor* was absent perhaps due to its scarcity at Lawachara.

Large size of fruit and scarcity of large frugivorous bird species like Hornbill might be a reason of our failure to find any bird consumer. Raihan (2008) also didn't found any of 29 frugivorous birds species using *F. variegata* at the same study area and in four other protected areas. Lambert and Marshall (1991) reported *F. variegata* as non bird-dispersed fig tree in Malaysia and stated bats, terrestrial mammal and arboreal mammal as known dispersal agents. Lighton (1986) reported Hornbill may be the only dispersal agents for some large, capsular fruits produced by many Meliaceae, Moraceae and Myristicaceae.

Figs are often regarded as keystone resources in tropical forests. Our study found four globally threatened primates and 35% of total mammal species in Lawachara consumed figs of *F. variegata*. This suggests the importance of *F. variegata* for mammals and birds. Planting seedlings could be an effective strategy to increase fruit resources at Lawachara as reserve management plan.

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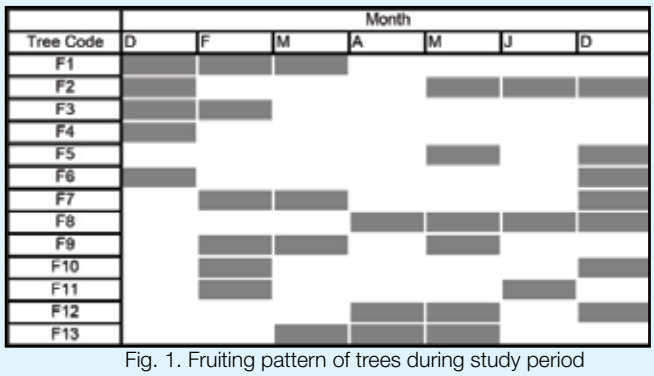

Fig. 1. Fruiting pattern of trees during study period

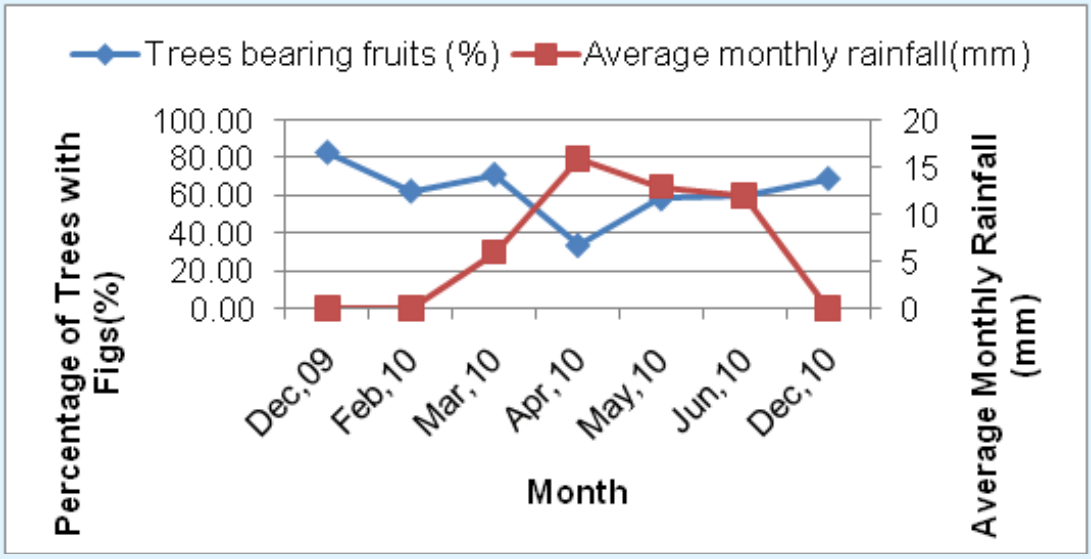

Fig. 2. The mean monthly rainfall (mm) and mean monthly percentage of fig-bearing trees in a population of 13 reproductive individuals of *F. variegata*.

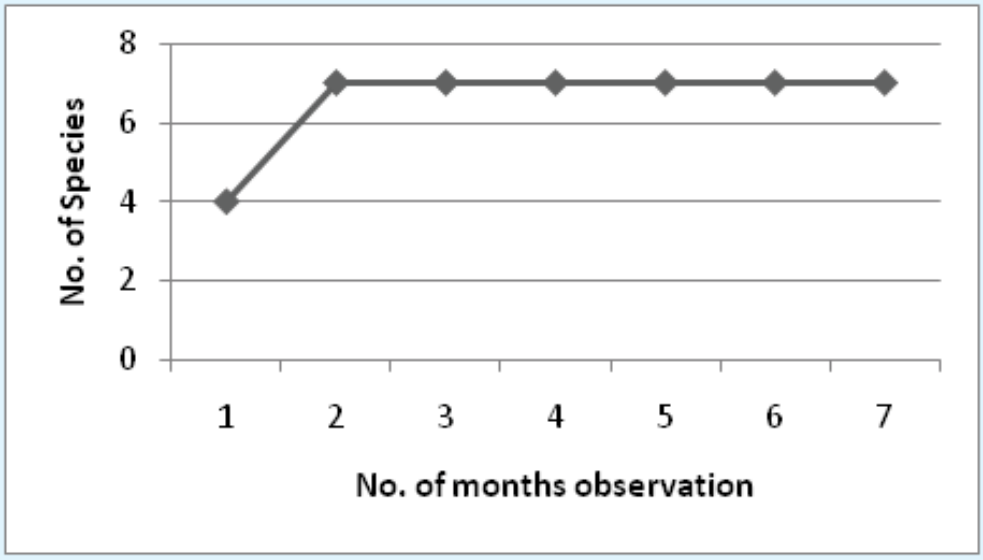

Fig. 3. Species accumulation curve for species feeding on the figs of *Ficus variegata* in Lawachar National Park.

Notes on the status and ecology of some selected Falcons of Bangladesh

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Abstract

The Bangladesh Falcon Research Project was initially started to investigate the status and breeding ecology of the Red-headed Falcon (*Falco chicquera*). Later the research was extended to the Amur (*F. amurensis*), Laggar (*F. jugger*), Peregrine (*F. peregrinus*) and Saker Falcon (*F. cherrug*). Eleven breeding pairs of Red-headed Falcon were located in 6 districts (Dhaka, Narayangonj, Gazipur, Noakhali, Barisal and Cox's bazar). Seven more breeding pairs were suspected. Nests were located in Palm trees (*Cocos, Borassus*), Debdaru tree (*Polyalthia* sp.) and man-made structures (almost all on electric pylons). Breeding biology of Red-headed Falcon revealed an incubation period, which is longer than that reported for the closely related African Red-necked Falcon (*Falco ruficollis*) and larger species of falcons. Females Red-headed Falcon feed the males as chick feeding during the entire of the breeding period. They mainly feed on House Sparrow (*Passer domesticus*) and also small bats (*Pipistrellus* sp.) in urban situations. The falcons return to their favoured roost sites usually late evening and the same locations are used throughout the year. Two new return migration and one migration locations (possible routes) were discovered for Amur Falcon. Sightings of Peregrine Falcon increased during the study period (2006-2014). Peregrine (*Falco peregrinus calidus*) was recorded at 13 different points of Dhaka city. Indian Peregrine (*Falco peregrinus peregrinator*) was recorded for the first time for Bangladesh. Laggar Falcon was reported from the northern dry parts of Bangladesh after a long interval. No observation of Saker was recorded in central, south-east and north-east but the species may possibly be present in the northern dry parts of Bangladesh.

Introduction

Bangladesh has a vast avian diversity more than 700 species birds reported so far by Khan, 2010. Among 53 species raptors occurred in Bangladesh of which 10 species were falcons (Khan, 2010).

In this study some aspects of biology and ecology of less studied falcons were made. In 2006 when "Birds of Prey of the Indian Subcontinent" by Rishad Naoroji was published this study as Bangladesh Falcon Research Project was established at the same time. Under the project breeding biology, roosting behavior, feeding during their breeding and non breeding season and movement of these falcons were made. Density and occurrence of Peregrine Falcon, migration and return migration of Amur Falcon and occurrence of Laggar and Saker Falcon studied as well under this project.

Methods

Direct observations made on Red-headed Falcon. Focal animal sampling method used to study breeding biology of Red-headed Falcon. Look-See method used for opportunistic study during the travel for this research throughout the country (mainly north-east and south-east). Communication and electric pylons surveyed for Peregrine and Saker falcon. Social networking site used to inform any kind of falcon sightings. A Kowa spotting scope 20×—60×. Model: Kowa TSN—664 (made in Japan) and 10×42 binoculars used during the study.

Results

Ecology of Red-headed Falcon

Breeding signs as mating and female feeding male observed in December and nest site occupies in January. Red-headed falcons lay their eggs at the end of January to early February and chicks fledged at the end of March to early April. Incubation period was more than 35 days. Male and female both shared incubation duty and largely by female. Only 2 nests were possible to check and clutch sizes were 3 and 4. Chicks leave nest at end of March to early April after >30 days of nestling period. Fledglings range from 1-4. Few cases new breeding attempts were noted after loss of the first clutch. In one case one pair successfully reared a single chick from replacement clutch and resulted late brood. Nest located Palm trees (*Cocos, Borassus*), Debdaru tree (*Polyalthia*) and man-made structures (almost all in electric pylon). 6 nest located in trees and 17 in man-made structures. Females feed the males from onset of the breeding to post-fledgling period. Exclusively feeds on small birds. Diet consists mainly House sparrow (*Passer domesticus*) and followed by bats (*Pipistrellus*) (urban population). Foraging recorded near estuary, agricultural land and densely populated urban areas.

Roosting site of 4 pairs determined and studied during breeding and post-breeding time. 2 pairs used the same site almost exclusively throughout of the year and one pair infrequently used same site throughout of the year.

Migration of Amur Falcon

Amur Falcon study began in 2010 based on an opportunistic sighting in Dhaka. Since 2010 Dhaka route regularly monitored. By this route from single individuals to large flocks numbering up to c.200 Amur counted. This year (2014) few Eurasian Hobbies *Falco subbute*o, an oriental Honey Buzzard *Pernis ptilorhynchus* also recorded this site during return migration. This route used as migration and return migration route by Amur. In 2011 one more new migration route discovered in Cox's bazar district (south-east). Since then regularly monitored. Recorded single individuals up to a flock of 20 birds migrated over this site headed to the sea Bay of Bengal. Few birds make stopover at this site. This year another return migration route discovered in Rangamati district (south-east). From single individuals to nearly 100 birds recorded during return migration over this site. This is also a stopover site. North-east is a regular migration and return migration route. Few birds make stopovers at this site. Single individuals to small flock of up to 40 birds regularly observed over this site during migration and return migration (T. Khan& M. A. Khan pers. comm.). In 2013 middle of November c. 150 birds observed in mangrove forest Sundarbans (S. Hussain pers. comm.). Migration observed in October and November and return migration observed from late April to June. Peak is in May.

Birds observed to hunt insects. In north-east and south-east birds observed to hunt on termites.

Survey on Peregrine Falcon

Travel results almost all over the country (except most of the northern parts) in recent past showed wintering Peregrine distributed at coastal , riverine , estuary, shore, agricultural lands, urban area, mangrove forest (Sundarbans). 13 opportunistic sightings from 13 different locations recorded from the capital Dhaka city. A pylon survey made in southern parts of Dhaka (outside of city) and found 7 Peregrines (one juvenile and 6 adults including 2 pairs) within c.9 km. Only *Falco peregrinus calidus* subspecies recorded in Bangladesh. *Falco peregrinus peregrinator* presence was suspected. On 10 October 2013 a single Indian Peregrine recorded for the first time in Bangladesh. The bird recorded in Dhaka at 07h30 perched on an electric pylon. It was later mobbed by crows. Second peregrinator recorded from Kaptai National Park (south-east region). The bird perched on a tree at 10h 30 (*S. Mohsanin pers. comm.*). Interviews from pigeon keepers from Dhaka known Peregrine considered as serious threat for domestic pigeons. Two Peregrines shoot death by pigeon keeper in the past.

Roosting observed in Dhaka and Cox's bazar district in Communication and electric pylon. Observed to feed on domestic pigeons in urban areas. An urban individual observed to feed on House Sparrow and *Pipistrellus* bat (*A. Maruf pers.comm.*). Observed to chase on domestic pigeons, waders, Indian Flying Fox *Pteropus giganteus*.

Search for Saker Falcon

During my travel in north-east, south-east last few years I always had a look for Saker. This year I surveyed southern part of Dhaka for Peregrine and Saker. No Saker detected at all.

Sighting of Laggar Falcon

In 2010, December a Lggar sighted in Dinajpur district (most northern part of Bangladesh). The bird perched on electric cable over an agricultural land (Pender, 2012).

Discussion

Red-headed Falcon (Scientific name) is a little studied falcon (Naoroji, 2007). Few published information on the study species in the Indian Subcontinent are: Dharmakumarsinhji (1954), Dharap (1974), Khan (1978), Gole (1980), Ingalhallikar (1988), Subramayana (1982, 1985), Foysal (2010) and Naoroji (2011). Under BFRP total breeding biology studied. Interesting findings of their incubation period and females feed males entire of the breeding season. Incubation period of African subspecies is longer and incubation and nestling period is 14 days longer than similar- sized falcons (Osborne, 1981). Current study suggests incubation period of Asian subspecies is longer than African subspecies. Why the incubation period is longer than similar sized falcons? More research needed. This zoological research may open a new window to science. Post-fledging dispersal distance is not known. Radio or satellite tagging of juvenile can reveal post-fledging dispersal distance. Females feeding to males previously recorded during in incubation and nestling period (Subramanya, 1985 and Naoroji, 2011). Current research revealed females feed to males during the entire of the breeding period. Why do the females feed the males during breeding period? Diet study suggests they consume more Pipistrellus bats than previously thought.

Red-headed Falcon is a rare resident of Bangladesh (Khan, 1996, Naoroji, 2007, Khan, 2008, Siddiqui et al., 2008). Country wide survey needed to estimate current population of this resident falcon. Current study suggests urban

population occupying man- made structures. Dhaka city is considered is one of the polluted cities of the world. Study needed to assess the impact of environmental pollution on their life cycle.

Before this study there was not much information about migration and return migration of Amur Falcon in Bangladesh. Return migration is poorly known entire of the Indian subcontinent (Naoroji, 2007). Under the project two important return migration routes discovered. North-east India is an important stopover site of Amur Falcon. Large numbers bird up to 18,000 recorded in central Assam (Phukan and Nagar, 2003). Regular migration, return migration and stop over site north-east region of Bangladesh are close to Assam. Here 40 birds have been recorded. All satellite tracked birds observed to pass through Bangladesh. Current research discovered maximum 200 birds passed through Bangladesh. It's a big question how do the thousands birds migrate from North-east India if they do not use path of Bangladesh?

Peregrine Falcon considered as a rare winter visitor in Bangladesh (Naoroji, 2007 and Siddiqui et al., 2008). Current study showed Peregrine is a common winter visitor in Bangladesh. Presence of Indian Peregrine in Bangladesh was suspected (Naoroji, 2007). Under BFRP 2 individuals confirmedly recorded for the first time for Bangladesh. Perhaps peregrinator is a regular winter visitor in Bangladesh and lesser number than calidus. Two shoot death recorded in the past. More study needed about interaction with pigeon keepers. While southern parts of Dhaka is well known for pigeon keeping. All diets data are opportunistic. A systematic research can be done on wintering Peregrine diet in all occupied habitats.

Laggar Falcon is considered as a rare resident in Bangladesh (Naoroji, 2007, Khan, 2008 and Siddiqui et al., 2008). No breeding recorded in Bangladesh. Recent sightings recorded from northern parts of Bangladesh. Naoroji (2007) mentioned they favors arid to semi-arid open habitat. Northern parts of Bangladesh is comparatively dry than others part of the country where recently sighted. Systematic survey in the northern parts may reveal real status of Laggar Falcon in Bangladesh.

Saker Falcon is a vagrant in Bangladesh (Naoroji, 2007 and Siddiqui et al., 2008). Only one record from near northern part (Thompson et al., 1993). Throughout of the subcontinent it's a rare and uncommon winter visitor. Prefers arid and semi-arid areas (Naoroji, 2007). Northern parts of Bangladesh is arid to semi-arid. Intensive survey in the northern parts may reveal status of Saker Falcon in Bangladesh.

Lesser Kestrel (*Falco naumanni*) is a rare passage migrant. There is a recent single record of a flock of 200 birds passing through north-east (Halder in Siddiqui et al., 2008). Thereafter no sighting recorded. Naoroji (2007) mentioned they may migrate associate with Amur and Common Kestrel. North-east is a regular Amur migration route. More study needed on their migration.

Collared Falconet (*Microhierax caerulescens*) is no recent record from Bangladesh. . Only two old records known from north-east and most northern region (Rashid, 1967 and Roberts, 1970).

More and detailed study is needed to assess the population and breeding biology of the less studied falcons of Bangladesh.

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Radio-telemetry study of Burmese python (*Python molurus bivittatus*) and elongated tortoise (*Indotestudo elongata*) in Lawachara National Park, Bangladesh: a preliminary observation

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Abstract

Burmese python (*Python molurus bivittatus*) and Elongated Tortoise (*Indotestudo elongata*) are two threatened reptiles of Bangladesh. Due to anthropogenic activities, these two species are thought to be rapidly declining in Bangladesh, and in much of their native range. A thorough understanding of species ecology is prerequisite for species conservation. However, very little is known regarding the ecology and natural history of these two species in Bangladesh territory. A collaborative study was initiated in Lawachara National Park (LNP) in 2013. The overall goal of the project is to understand the ecology of Burmese pythons and elongated tortoises in agriculture-forest mosaic landscape and promote reptile conservation among local communities. During the first year of the study, we radio tracked four adult Burmese pythons and eight elongated tortoises (two residents and six translocated individuals) in LNP. A number of parameters were evaluated for pythons and tortoises: home range size, microhabitat use, die activity pattern, burrow use, thermal preference, annual weight changes and annual survivorship. None of the telemetered animals died during the study. The pythons showed preference to human modified habitat over natural forest. The translocated tortoises appeared to adjust with the new environment. The mean home range of tagged python was calculated 95.67 ha using kernel density estimator (KDE). The study will be continued in the coming years to better understand their ecological needs.

Introduction

Indian or Burmese python (*Python molurus*) is one of the largest snakes of the world, native to South and Southeast Asia. This species is endangered in Bangladesh and much of their native ranges, and listed as Vulnerable by the IUCN and on CITES Appendix-1. Bothsubspecies, *Python molurus molurus* (Indian python) and *Python molurus bivittatus* (Burmese python) occur in Bangladesh (Kabiret al, 2009; Baker et al; 2010). Schleip and O'Shea (2010) and Jacobs et al. (2009) recently concluded that *Python molurus* and *Python bivittatus* are two distinct species, however this has not been widely accepted among scientists (Dorcaset al., 2010; Wilson et al, 2010). Once distributed throughout Bangladesh (Das, 1996), python populations are now fragmented in small and disjunct populations. Habitat loss and persecution by local people are thought to be the major causes for their decline. Pythons are dietary generalists, feed on variety of birds, small to large mammals and other reptiles (Daniel, 2002; Whitaker 2004; Kabiret al, 2009); thus act as an apex predator and play a crucial role to maintain the natural balance of the ecosystem.

Elongated Tortoise (*Indotestudo elongata*) is listed as endangered by the IUCN. They are thought to be rapidly declining throughout their range. Despite their conservation status, very little is known about the ecological needs of elongated tortoise (*I. elongata)*. Data on their habitat use, home range size, movement and activity pattern are scanty (Flora et al. 2014; Van Dijk 1998). In Bangladesh, *I. elongata* occurs in the mixed-evergreen forest of Sylhet and Chittagong Division. Hunting for consumption is probably the most immediate threats for *I. elongata* in Bangladesh. Due the persistent harvesting for many years it is likely that *I. elongata* population in most part of Bangladesh has declined to a level that with no intervention it will likely cause local extinctions of these already low-density populations. With that in mind, the study was initiated in Lawachara National Park to assess effectiveness of reinforcement as a conservation tool to re-establish viable populations from rescued elongated tortoises through a release study with intensive post release monitoring with the aid of radio-telemetry technique.

The objectives of the python and tortoise study were to use radio telemetry to understand the ecological needs of Burmese python and elongated tortoise,

Methodology

The study site -Lawachara National Park (LNP) (24º20'N, 91º47'E) - is a 1,250 hectares mixed evergreen forest situated in northeastern Bangladesh (Fig. 1). LNP was established in 1996 and is one of the last remaining patches of mixed evergreen forest in the country. The national park is surrounded by tea plantation estates and human habitations. Pythons are found in these tea estates as well as the park, and provided an opportunity to compare habitat within the national park to that within a more disturbed environment. Environmental data were collected from Bangladesh Metrological Department, Srimongal Station.

Radio Telemetry Procedure:

The study primarily involved radio-telemetry study of Burmese pythons and Elongated Tortoises. Pythons that entered the villages and captured by the local people were collected with permission from the Forest Department. Captured snakes were sexed, measured, and weighed. Internal radio transmitters (AI-2, Holohil Systems Ltd., Canada; 25gm; battery life 3 years; 144-145MHz) were implanted in the coelomic cavity of pythons by professional veterinarian following Reinert and Cundall (1982). The transmitters contained a miniature data logger for recording internal body temperature every hour. The transmitters and data logger weighed less than 0.5% of the total body weight of the pythons. Four Burmese pythons (2 males and 2 females) were implanted and radio tracked. For identification purpose the pythons were named as ASHA, BONNIE, CHAITY and DEAN. Each of the pythons with implants had a specific radio frequency. External transmitters (RI-2B 10gmand SI-2 5 gm, Holohil Systems Ltd, Canada; 144-145MHz) were epoxy-glued on the anterior dorso-lateral carapace of eight (8) Elongated Tortoises (2 resident, 6 translocated; 1male, 7 females) following Boarman et al. (1998). The external transmitters weighed less than 1% of the total body weight of the tortoise.

Field work was assisted by locals, trained as para-biologists and students from Bangladeshi universities. Data related to weather, GPS location, habitat, micro-habitat, ambient temperature and humidity, activity, body position and exposure and proximity to human habitation were collected at least once-a-day for pythons and tortoises to deduce their home range, diel activity pattern, habitat use and thermo-regulation. Both pythons and tortoises were tracked at least once every day.

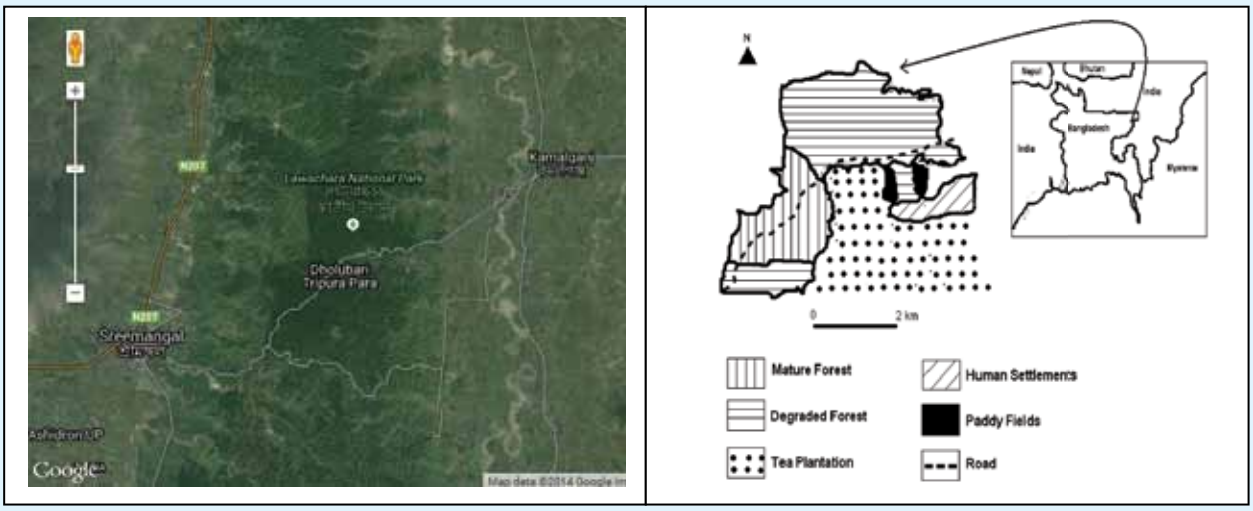

Fig. 1. Map of the study site, Lawachara National Park.

RESULTS:

Burmese Pythons

External measurements of the tagged pythons measured at the time of capture are given in Table 1. The animals were surgically implanted within 2-7 days of the capture and released within 3-7 days after the surgical wound was healed.

Table 1. External morphological measurements of the tagged Burmese pythons with release dates after radio transmitter implantation (SVL – Snout-Vent Length, Wt – Weight, HL – Head Length, HW – Head Width)

ID	Sex	SVL (cm)	Tail (cm)	Total Length (feet)	Wt (kg)	HL (cm)	HW (cm)	Body Girth (cm)	Release Date
ASHA	Female	210	30	7.9	8.37	8.4	5.4	28	17-Jul-13
BONNIE	Male	244.5	40	9.3	10.54	8.8	5.3	27.9	14-Oct-13
CHAITY	Female	304.8	40.9	11.35	12.76	10	5.8	29.2	14-Oct-13
DEAN	Male	173	30.5	6.8	3.5	6.9	3.9	21.8	4-Aug-14

After the release the pythons used to remain near the release site between 2-7 days and there after started to move. The pythons being an ambush predator usually did not move on a daily basis. For example, ASHA was found to be at the same place for over 50 days. The distances were recorded based on the linear measurement from one GPS location to the other.

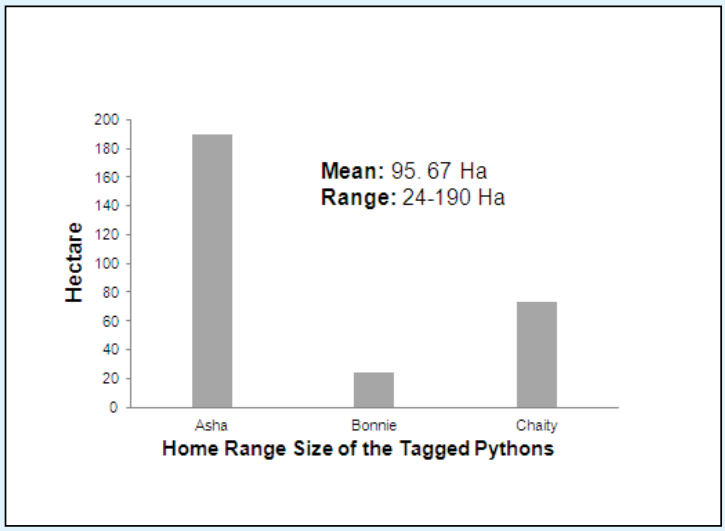

Fig: 3. Home range size of tagged pythons: ASHA & CHAITY are females and BONNIE male

Home ranges for the individual pythons were determined using location data between releases after implantation and first re-capture in a village. Kernel estimator was applied to estimate the home range using 55%-95% buffer area. Home range for the fourth tagged python, DEAN was not analyzed due to insufficient data.

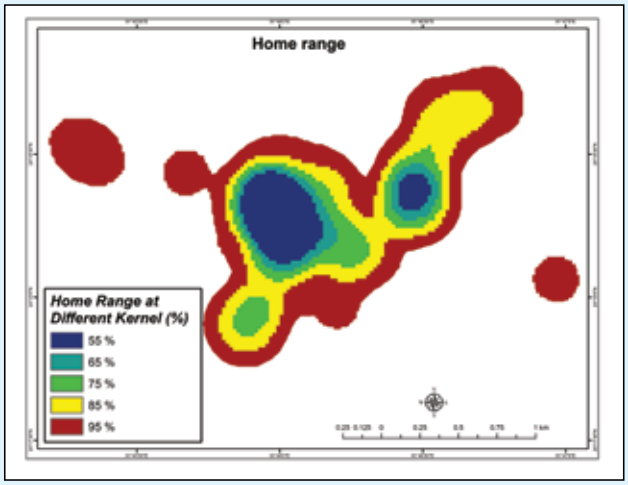

Fig. 4. Home Range of ASHA (female) at different confidence intervals using kernel method.

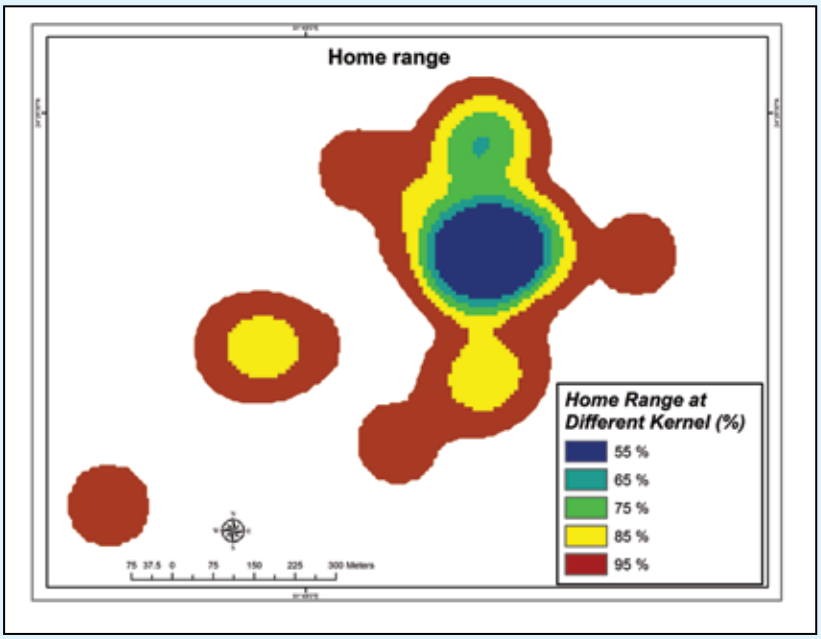

Fig. 5. Home range of BONNIE using kernel method at different confidence intervals

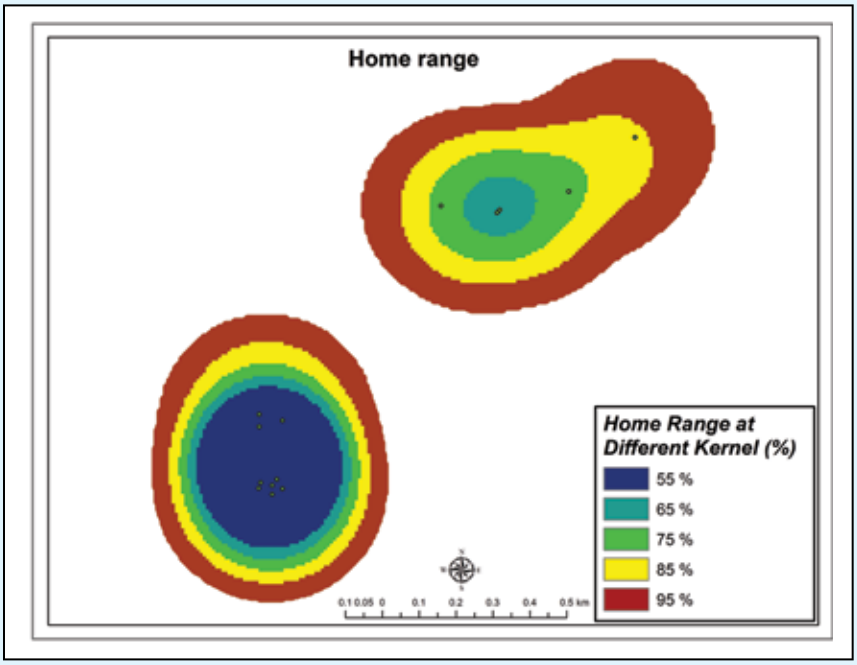

Fig. 6. Home range of CHAITY using kernel method at different confidence intervals

The tagged pythons were tracked for different periods, for example ASHA was tracked since 17 July 2013 while the other two were tracked since 14 October 2013 (see Table 1). Activity centers may vary for individual animals but are usually limited to one (blue area). However for ASHA and CHAITY two activity centers are observed which might be due to recaptures in the villages and releasing at a different site. This was also a problem in estimating the actual home range since kernel estimator determines the home ranges based on the numbers and frequency of radio locations. Moreover the location points during the whole of tracking period were not used for home range estimation due to the capture when the tagged python entered a village to hunt particularly ducks and were captured by the local people.

The home range area covered different habitat types like moderately and degraded forests, tea plantations, human habitations, orchards, water bodies (streams, ponds). The data for all the three tracked pythons were pooled to determine

the habitat(s) generally preferred by the pythons under this altered and heavily disturbed environment. Fig. 6 also indicate that the pythons spend most of their time under bushes or in burrows and in degraded habitats including tea plantation and in ponds close to human habitation.

Seasonal variation in the use of different habitats was also prominent. Bush and thickets of the moderate, degraded habitats were primarily used in all seasons however the use of burrows and water bodies increased during winter (Fig. 7). This may be for regulating the body temperature due to its poikilothermic behavior. During winter the ambient air temperature are lower than that of the burrows and water.

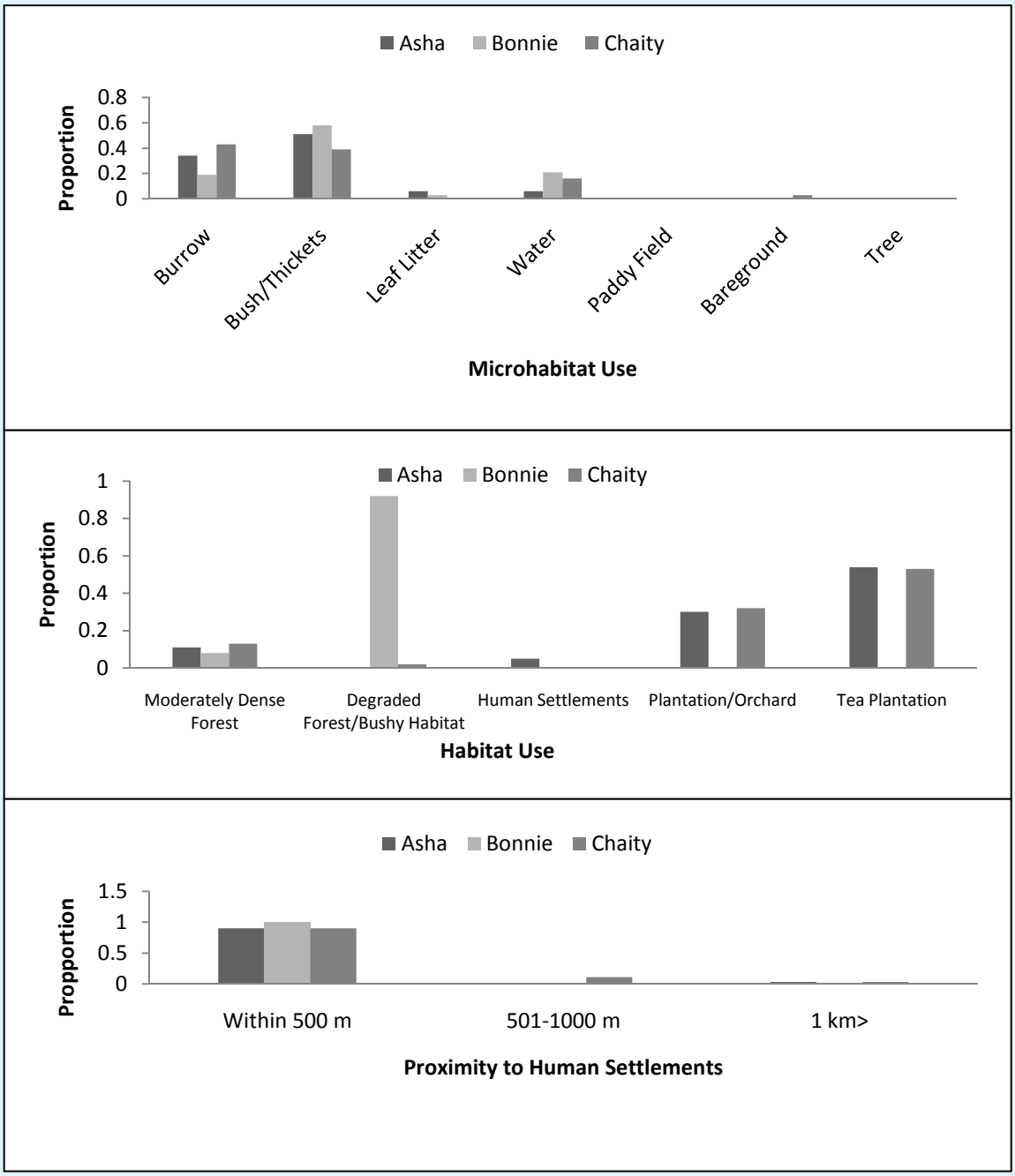

Fig.7. Graph based on the numbers of locations showing the proportions of micro-habitat and habitat use and proximity to human habitation of the three pythons combined. It clearly indicates that the pythons spend most of their time under bushes or in burrows and in degraded habitats including tea plantation and in ponds close to human habitation.

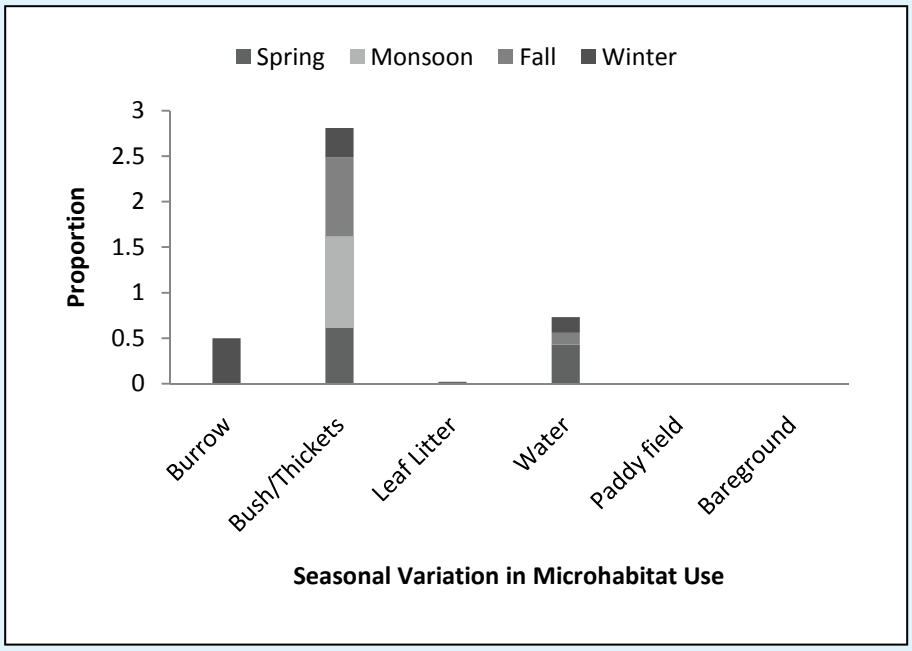

Fig. 8. Graph using pooled data to show seasonal variation in micro habitat use.

Elongated Tortoise

Opportunistic harvesting for domestic consumption is probably the most immediate threats for elongated tortoise in LNP. With persistent collection for many years the tortoise population in LNP and surrounding areas are likely to be of low density. A total of eight tortoises were radio tracked in LNP. The two resident specimens were collected from a tea plantation adjacent to LNP with the help of local people in 2014. Six specimens for translocation study were rescued from hunter's possession in Alikodom and Lama, Bandarban District. Thorough health assessments were conducted by a trained veterinarian before releasing the tortoises in LNP. External morphological measurements are given in the Table 2 below.

Table 2. External morphological measurements of tagged Elongated Tortoises. [SCL-Straight Carapace Length, Resident – Captured within LNP, Translocated – Captured from outside LNP (from Bandarban)]

ID	Sex	SCL (mm)	Max Width (mm)	Max Height (mm)	Weight (g)	Note	Transmitter Attached
ALO	Female	244	153	111	1935	Resident	13-Jun-14
BURAO	Female	237	155	90	1743	Translocated	13-Jun-14
CLANG	Male	260	160	110	2537	Translocated	13-Jun-14
DOLLY	Female	124	99	59	363	Translocated	11-Sep-14
ERIN	Female	202	143	91	1283	Translocated	11-Sep-14
FARZANA	Female	230	151	101	1768	Translocated	11-Sep-14
GINA	Female	280	190	114	2509	Translocated	11-Sep-14
HASNA	Female	260	163	114	2089	Resident	26-Sep-14

The tortoises remained close to their release sites for the first few days thereafter looked for suitable hiding places. As is demonstrated from the graph below (Fig. 9) the tortoises spend most of their time hiding under the leaf litter, or under bushes or in the burrows. This keeps them away from the hunter's or collector's sight.

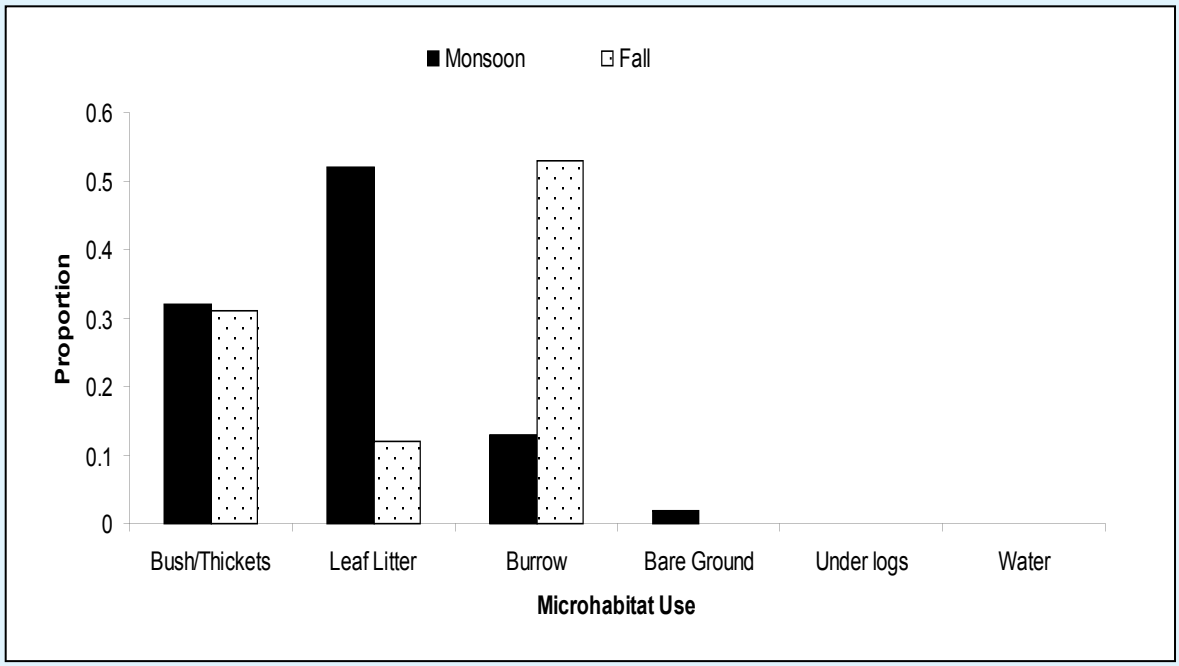

Fig. 9. Graph showing microhabitat utilization by the Elongated tortoises. It is evident that the tortoises spend a significant amount of time hiding under the leaf litter, or burrows or under bushes varying with the season.

These tortoises use burrows built by other animals like porcupines or the crevices developed naturally or at the bases of large trees. The leaf litters and bush/thickets provide a good camouflage against 'human' or other predators. Fig. 10 also shows the predominating hiding tendency which may be one of their strategies for survival in this human dominated landscape.

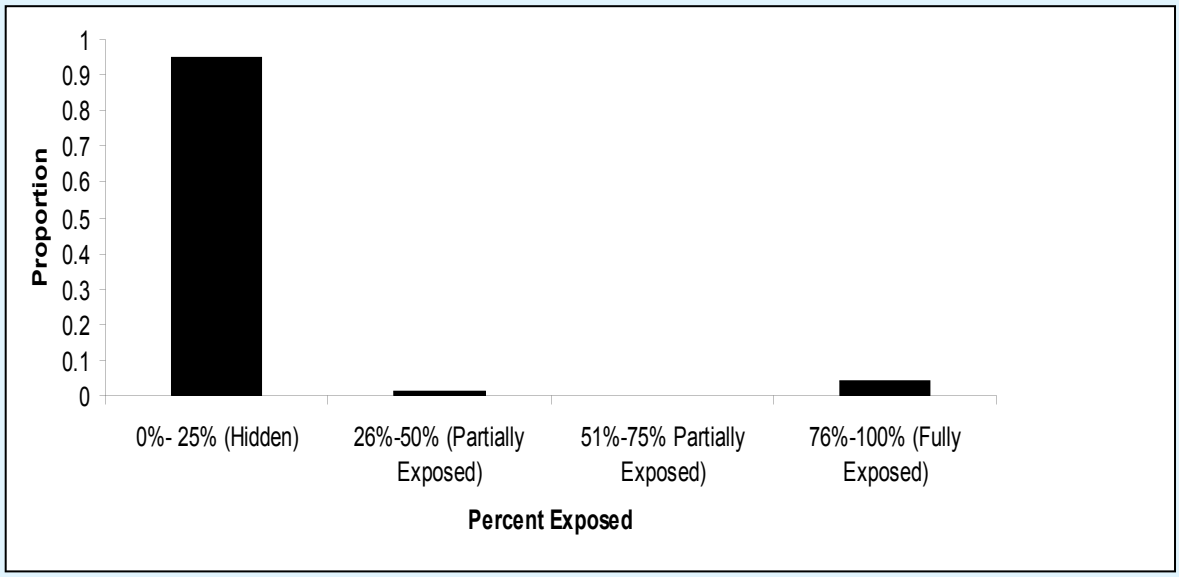

Fig. 10. Elongated tortoises are secretive as seen from the graph, where more than 90% of their time is spent hiding in different microhabitats.

Discussion:

The radio telemetry study of pythons and tortoises is the first of its kind in Bangladesh, and probably the only on-going study in Asia. The study will likely to reveal a lot of interesting information related to the little known ecology and biology of these two species in their native land. This information may be used to develop a pragmatic and community-participated

conservation initiative for their management in the wild. The relationship between the ambient temperature and the python's or tortoise's body temperature may be explored further when the study is completed and data from temperature loggers are downloaded and analyzed.

Translocated tortoises appeared to exhibit normal behavior. None of the residents or translocated individuals died or harvested during the first six months of the study duration. Preliminary results thus indicate that population reinforcement might be a viable tool for conservation of this species. However, long term post-release monitoring must be implemented to better understand the efficacy of this technique.

Robust statistical analyses were not possible due to the limited sample size of pythons and tortoises tracked. The study is on-going and sample size for tracking pythons will be increased to better understand the ecological needs of these two species.

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Indian flying fox (*Pteropus giganteus*) roosts in north Bengal of Bangladesh

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Abstract

A preliminary survey on roost location and roost size of Indian Flying Fox (*Pteropus giganteus*) was conducted as a part of IUCN Red List Mammal survey in the northern part of Bangladesh between 27-08-2014 and 01-09-2014. Flying Fox roosts were detected through visual encounter and also by observing the emergence of bats during dusk. Local people were also consulted regarding the location of roosts. Where possible a total count of the animals was obtained by using binoculars. In high density roosts where total count was not possible, an approximation in addition to total count was used by the team of five members and the average value was considered for that roost size. A total of 8 roosts were detected. Roost size varied from 12 to 3000 individuals with the mean 746.50 ± 1000.43 (n = 8).The largest roost having a population of about 3000 individuals were detected from Dinajpur district. Seven species of trees, ranging in height from approximately 60-120 feet (mean = 71.43 ± 18.09, n= 14) were found to be used as roost trees. *Bombax cebia* (Shimul) supported about half of the total bat individuals (49.40%) surveyed, followed by *Ficus bengalensis* (21.96%), *Ficus religiosa* (11.72%), *Mangifera indica* (8.71%), *Albizia saman* (5.86%), *Bambusa* sp. (1.51%) and *Eucalypts* sp. (0.84%). The northern part of the country is famous for fruits, especially mango and lychee. Local people claimed that farmers use fishing net to protect their fruits from Flying Fox which cause the death of a huge number of bats. An outbreak of Nipah virus is also reported from this region. As Flying Foxes use their roost sites year after year, long term research on ecology and evolution of this species as well as surveillance of Nipah virus is possible in these roost sites. Awareness building among the farmers and local people about these roost sites could mitigate the unnecessary deaths of these Flying Fox as well as prevent future Nipah outbreaks in this region.

Key Words: *Pteropus giganteus, colony, Flying Fox, Bangladesh, Nipah*

Introduction

Indian Flying Fox (*Pteropus giganteus*) is the largest fruit bat in Bangladesh and is widely distributed (Khan 1982, 2001).It is nocturnal and spends its daytime in roost that range from small to very large. Their roost size depends on suitable roost sites and also the availability of fruit trees. They may fly several kilometers in search of food (Francis 2008). Though Flying Fox play an important, perhaps essential, role in forest ecosystems as pollinators and seed dispersers for many trees, their number has been reducing day by day due to different anthropogenic effects (Pearson and Rainey 1992).Fruit bats are the natural reservoir of the zoonotic Nipah virus which may be spread via bat saliva or urine (Lubyet al. 2009). The northern part of the country is famous for fruit production as well as for the production of date palm sap both of which are preferred food sources for fruit bats.

Major reductions or extinction of flying fox populations would presage decreases in forest regeneration and diversity, and reduced productivity or decline of many plants that are economically important to man.

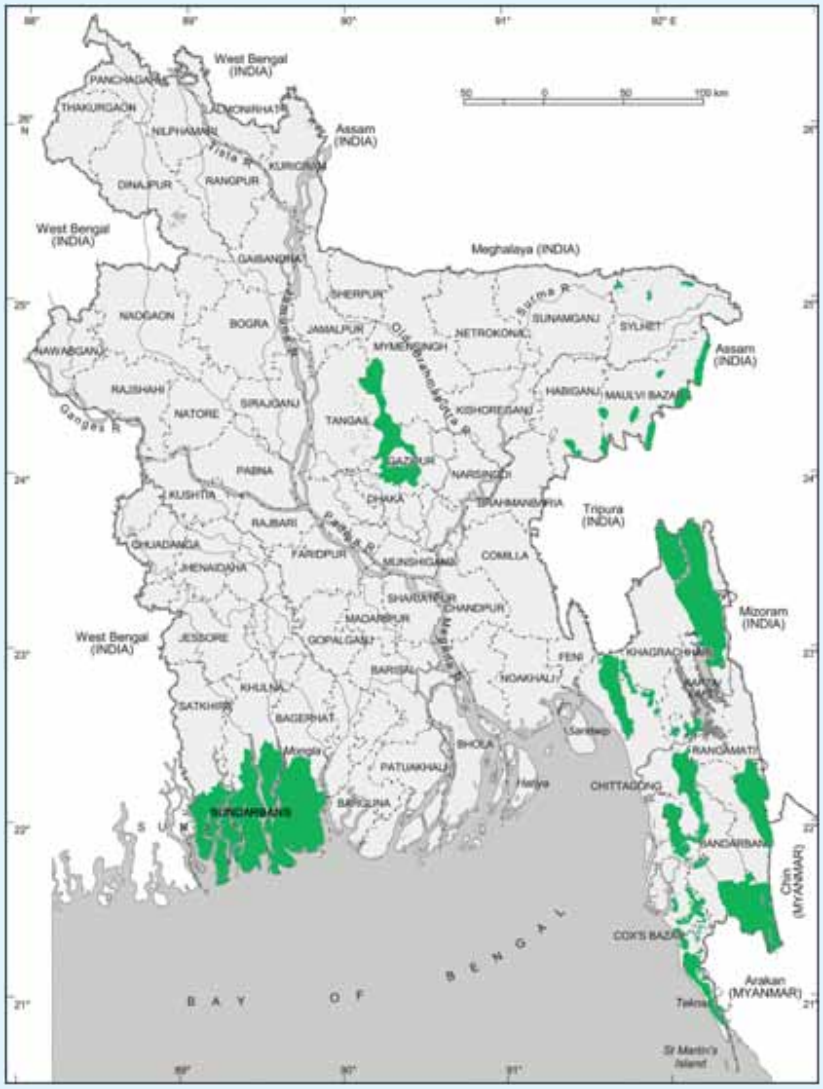
Despite their importance in maintaining forest diversity and their role in the transmission of Nipah virus, research on bats remains neglected in Bangladesh. While limited studies have been conducted on bat diversity (Khan 2001, Aziz et al. 2007, Shih an 2014a) and roosting sites in Bangladesh (Shih an 2014b), research focused on Flying Fox roosting sites as well as roost composition could open a new research window. As Flying Fox use the same roost site year after year, studies on these animals could be a good model for studying population genetics, bat evolutionary and disease transmission trends. This report takes a first step and focuses on the location and size of Flying Fox roosts in one part of Bangladesh.

Study Area

Most of the wildlife surveys in Bangladesh have been conducted in northeastern and southeastern parts of the country. Very few are known about the faunal diversity in northern part of the country especially small mammals. As a part of the mammal survey for the updating of IUCN Red List, we conducted a preliminary survey on bats in four districts viz. Panchaghar, Thakurgaon, Dinajpur and Sirajganj in the northern part of the Bangladesh. The northern part of the country is famous for huge production of fruits especially mango and lychee. Small patches of moist deciduous forests are also located in this region. This is a preliminary survey on Flying Fox roosts in these districts.

Methods

This preliminary 6 day study was conducted on Flying Fox roost location and roost size in the northern part of the country between 27 August 2014 and 01 September 2014. Local people were consulted for locating roosts. Flying Fox roosts were detected by visual encounter and also by observing the emergence of bats during dusk. Total population counts were taken using binoculars where possible. Direct counts were frequently impossible because of very large aggregation of bats or part of the group was hidden in the canopy (Krystufek, 2009). In high density roosts where total count was not possible, an approximation in addition to total count was used by the team of five members and the average value was considered for that roost size.



Note: location- 1=Maddha bila of Tetulia,2=Thakurgaon courtyard and police compound, 3=Graveyard Birol, 4=Temple Dinajpur, 5=Nimgachi Sirajganj and 6=Gojaria Sirajganj.

Map 1: Location of the bat roosts in northern part of Bangladesh.

Result and Discussion

A total of 8 roosts were identified in four districts. Roost size varied from 12 to 3000 individuals with the mean 746.50 ± 1000.43 (n = 8). The largest roost having a population of about 3000 individuals were detected from Birol of Dinajpur district. Seven species of trees, ranging the height about 60 ft to 120 ft (mean = 71.43 ± 18.09, n= 14) were found to use as roost tree. *Bombax cebia* (Shimul) supported about half of the total bat individuals (49.40%) surveyed, followed by *Ficus bengalensis* (21.96%), *Ficus religiosa* (11.72%), *Mangifera indica* (8.71%), *Albizia saman* (5.86%), *Bambusa* sp. (1.51%) and *Eucalypts* sp. (0.84%).

Majhbila Village, Tetulia
The Majhbila village is located at the northernmost tip of the country, very close to the Indian Border. The village area is covered with many species of fruit trees especially mango (*Mangifera indica*), litchi (Litchi litchi), plum, guava, jackfruit, kadam and also bamboo thickets (*Bambusa* sp.). A roost of Indian Flying Fox with 90 individuals was detected in a bamboo thicket (Table 1).

Courtyard, Thakurgaon
The courtyard is located in the heart of Thakurgaon district town. The courtyard compound is approximately 3 hectares. A large Banyan Tree (*Ficus bengalensis*) is situated at the center of the compound. A roost of 12 bats was recorded from this tree (Table 1). The compound becomes very crowded during office time due to court activities. Local people claimed that they saw many bats during holidays. They also claimed that they have seen hunting of bats from this compound for traditional medicine practices.

Police Station Compound, Thakurgaon
The police station compound is also situated in the heart of the town but this bat roost site enjoys more protection than the courtyard. The 4 hectares area of the police station compound has many large trees including Shimul (*Bombax ceiba*) and Aam (*Mangifera indica*) trees in which a roost of about 720 individuals was recorded. The *B. cebia* tree was the largest tree in this compound and supported most of the bats (~500 individuals) in this compound (Table 1). Local information supports that the Flying Fox roosts in this compound are at least 20 years old. Because entrance to and from this compound is restricted this compound enjoys more protection.

Dinajpur Temple
A Hindu temple of the Goddess Kali (Kali Mandir) is situated at the center of Dinajpur town. A roost of about 500 bats was recorded from a large Banyan tree (*Ficus bengalensis*).Hindus venerate Banyan trees and this tree's location within a temple afford it even more attention. Bats roosting here benefit from the religious protection provided to this tree.

Graveyard Roost 1, Birol, Dinajpur
A large graveyard compound of about 20 hectares is located in Birol Thana of Dinajpur district. This compound supports a good number of large trees along with a man-made pond. Two roosts of Flying Fox were recorded from the northeastern and southwestern corners of this compound. In our study, the largest colony of Flying Fox, approximately 3000 individuals, was recorded from this compound (Fig 1). To date, this is the largest reported roost of this species in Bangladesh. *Ficus bengalensis, Ficus religiosa* and *Ficus ceiba* provided roosts for this species.

Graveyard Roost 2, Birol, Dinajpur
Another roost of about 1250 bats was at the southwestern corner of this compound. A large Shimul (*Bombax ceiba*) tree provided shelter for this species.

Nimgachi Home Garden, Sirajganj
Nimgachi is a village of Rayganj Thana of Sirajganj district. The village is covered by many trees but most of these are exotic plantation. A roost of Flying Fox of about 50 individuals was recorded from a Eucalyptus sp.

Gojaria Home Garden, Sirajganj
Gojaria is another village close to Nimgachi. This village is covered by many species of plants including fruit trees. A roost of about 350 individuals was recorded from a Rain tree (*Albizia saman*) plant.

Centuries' old misconceptions and fear have resulted in most people in Bangladesh disliking bats. All the fruit bats in our country are considered as pests of banana, lychee, mango and other commercially important fruits (Khan 2001). The presence of bats in home gardens or farms is not welcomed by the owners. Farmers use fishnets to cover their fruit trees, causing significant mortality of bats in this area. Overhead electric cables also contribute to bat deaths (Khan 2001, Shihan 2014b). Like other countries, local people and residents around the roosts are unhappy with the presence

of bats in their vicinity (Vyas and Upadhyay, 2014). They complain that entire roost area is noisy with the screaming and squabbling of bats and the continuous smelling foul due to bat droppings. The risk of Nipah virus infection is also high in these areas. Local people should be made aware to avoid direct contact with bats as well as not to consume any fruits that may have been partially eaten by bats. Alternative strategy should be used to prevent bats in fruit gardens rather than using fishing net. Electric wires should be insulated close to fruit sources. Further research is needed to identify flying fox roost location and their status throughout Bangladesh.

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Biodiversity and conservation of fin and shellfishes of the River Sangu, Bangladesh

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Abstract

The River Sangu (270 km long, 173 km within Bangladesh territory) originated from the North Arakan hill of Myanmar and after traversing 270 km meet with the Bay of Bengal and thus significantly important for creating diversified habitats for aquatic organisms. Present investigation was based on monthly field observation, and fish and shellfish sample collection from the catch of the fisher folk. They used different gears for the catch during May 2010- to April 2014. The species richness in the Sangu River was found to be 127 (109 fin fish including 3 exotics and 18 shellfish) belonging to 14 orders (Finfish 13, shell fish 1) 47 families (Finfish 44, shell fish 3) and 94 genera(Finfish 87, shell fish 7). Maximum number of finfish species were recorded under the family Cyprinidae (26 species) followed by the family Gobiidae (11 species), whereas maximum number of shellfish (crustaceans) species were recorded under the family Palaemonidae (9 species) followed by Penaeidae (7 species) and Portunidae (2 species). Of the 109 finfish species, four belonged to the critically endangered, twelve to the endangered and nine to the vulnerable category of IUCN (2000). Two fin fishes, namely Oryziasdancena, and Ophieleotrisaporos were the new records from the River Sangu and from the inland waters of Bangladesh. Systematic lists of the fin and shell fishes have been appended. Conservation measures are being suggested to protect the habitat and diversity of the fish and shellfish fauna of the River Sangu for the sustainability of the fishery.

Key words: *Finfish and shell fish, Sangu River, Ichthyofauna, Conservation measures*

Introduction

The tidal river Sangu has originated from Myanmar at the North Arakan Hills and follows northerly in the Hill Tracts up to Bandarban and enters Bangladesh near Remarki, Thanchi Upazila, Bandarban District east and flows west across the Bandarban and four Upazilas (Satkania, Chandanaish, Anwara and Banskhali) of Chittagong district and finally falls into the Bay of Bengal at Kutubdia Channel between Khan khanabad (Banshkhali) and Gohira (Anwara),16 km south of Karnaphuliriver mouth after traversing about 270 km (173 km within Bangladesh territory) (Fig.1).The main tributaries of the Sangu are the Dolukhal, the Chandkhali, and the Kumira Khali. The Sangu is a very important river as it drains off the waters of four important Upazilas- Satkania, Chandanaish, Banshkhali and Anwara and also for fisheries, navigation, agriculture and sand collection. It has also connection with the River Halda through the Rivers Karnaphuli, Chandkhali and Sikalbahha Channel (Fig.1). The River is completely separated from the other major river systems (Ganges-Brahmaputra-Meghna) of Bangladesh. River Sangu is shallow in upstream and deep in lower region, which becomes violent during monsoon rain (May-July) due to high water flow coming from Bandarban hill and surrounding areas.

The River Sanguis also important as a one of the major habitats of Indian major carps (IMC), which migrate to the Halda River via Chandkhali, Shikalbaha and Karnaphuli for spawning during breeding season (Azadi, 1979, 1985; Patraand Azadi 1985, Tsai et al. 1981). IMC spawning and spawn fishery in Halda River is largely dependent on the stock status of major carps in the River Sangu and its adjacent Rivers. In south Chittagong, Sanguis one of the major sources of open water fishery. No works were found on the fish faunal diversity of the River Sangu except some limno-fishery-biological works by Azadi (2013), hill stream (including Bandarban) fishes by Ahmed et al. (2013) and Ganges River Dolphin status by Smith et al. (2008).However, some works were done on the finfish and shellfish diversity and Ichthyofauna of Halda River (Azadi and Arshad-ul-Alam 2011, 2013), fish fauna of Kaptai lake (Ahmed and Hasan, 1981, Hafizuddin et al.1989), fish sanctuary management (Ahmed et al. 2007), biodiversity of fish of Pagla River (Zafar et al. 2007),fishes of River Naff (Hossain et al. 2007), and biodiversity of hill stream fishes (Ahmed et al. 2013). The present study was conducted to know the finfish and shellfish species and their habitat preferences and status (endangered, critically endangered, and vulnerable)in the River Sangu and to provide some conservation measures. The findings might be useful to the researchers, planners and fishery biologists to formulate the policies to protect and conserve the river and its fisheries resources.

Materials and Methods

The study area covered 97.47 km from Bandarban-Keching-ghatpoint of Sangu River (Lat. 22º 10' 59.30" N, Long. 92° 13' 55.74" E) to Sangu River mouthopening point to the sea (Lat. 22º 13' 25.46" N, Long. 91º 48' 28.31" E), Bay of Bengal (Fig.1).

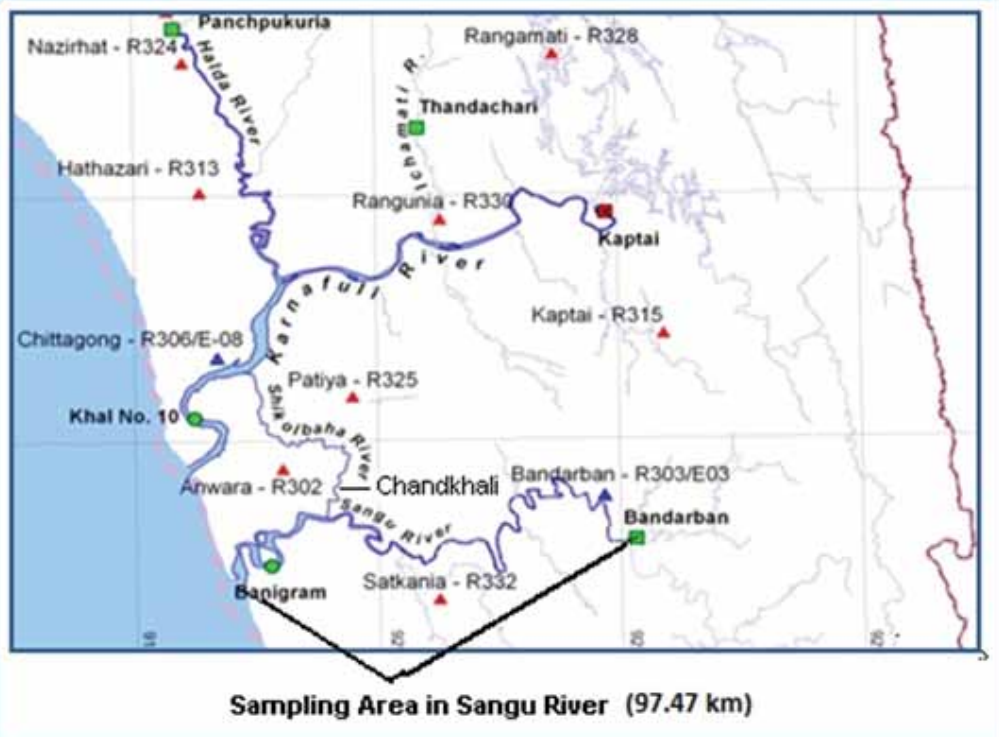

Fig.1. Map of the River Sangu showing the sampling area from Bandarban Keching-ghatpoint to River mouth estuary (97.47km) along with its four interconnected Rivers (Chandkhali, Shikalbaha, Karnafuli and Halda).

Present investigation was based on monthly field observation and fish and shellfish samples collection from fishermen catch for four years study period during May 2010 to April 2014. For the study of finfish and shellfish species of the Sangu River, samples were collected from the main fishing zones caught by different gears : Bandarban Keching-ghat point station (fish collected by gill net, cast net, seine net, hook and line), Dohazari point(by cast net, gill netand seine net), and Chandkhali joining point to Sangu River mouth (by Set bag net -SBN, enclosure net, cast net, scoop net,seine net, brush shelter, hook and line). Photographs of these catches were taken in fresh condition in the field. External features with colour patterns were noted in fresh condition. Specimens were preserved in 7% formaldehyde solution and taken to the Department of Zoology, University of Chittagong for further study and future reference. The classificatory scheme of fish has been followed mostly after Berg (1940) with a few modifications by Lagler (1962) and Rahman (2005). Identification and classification of fin fish were done with the help of Day (1889), Munro (1955),Jayaram (1981), Shafi and Quddus (1982) and Rahman (2005) while for crustaceans help was taken from Ahmed (1957), George (1969), Howlader (1976), Ficnham and Wickins (1976) and Shafi and Quddus (1982). Systematic list of finfish and shellfish species with habitat preference and threaten status as per IUCN Bangladesh (2000) were recorded.

Results and Discussion

A total of 127 (109 fin fish including 3 exotics and 18 shellfish) finfish and shell fish species belonging to 14 orders (Finfish 13, shell fish 1), 47 families (Finfish 44, shell fish 3) and 94 genera (Finfish 87, shellfish 7) were identified from the River Sangu and is shown in the Table 1 with systematic index, habitat preference and threaten status.

109 finfish species under 13 orders and 44 families and 18 shellfish (16 prawns and two crabs) under 1 order and 3 families were recorded from the River Sangu during the four years of study period (May 2010 - April 2014).

Maximum number of finfish species were recorded under the family Cyprinidae (26 species) followed by the family

Gobiidae (11 species); whereas maximum number of shellfish species were recorded under the family Palaemonidae (9 species) followed by Penaeidae (7 species) and Portunidae (2 species).

A heterogeneous assemblage of floodplain, pond, hilly stream, haor, beel, riverine, coastal, estuarine and marine fishes were found in this river with strong dominance of a few species.

Of the 109 finfish species recorded in this investigation, four belonged to the critically endangered, twelve to the endangered and nine to the vulnerable category according IUCN (2000). Six species (*Labeo ariza, Arius sagor, Oryzias dancena, Pseudapocryptes elongatus, Ophieleotris aporos,* and *Macrognathus aculeatus*) recorded in this study were not reported by IUCN (2000).Other than the River Halda, two fin fish species namely *Oryzias dancena* and *Ophieleotris aporos* were the new records from the River Sangu and also from the inland waters of Bangladesh. *Labeo ariza* was also available in lesser extent in the River Halda (Azadi and Arshad-ul-Alam 2013), which was not reported by most of the earlier authors except Ahmed et al. (2007) and Haque et al. (2007) from the rivers of Netrokona. In this study another cyprinid *Labeo angra* was recorded but was not found in Halda and Karnaphuli (Azadi 2013, Azadi and Arshad-ul-Alam 2013). Three exotic fishes which are found in the river Sangu were also reported from other inland open waters of Bangladesh both from lotic and lentic habitats viz. River Halda (Azadi and Arshad-ul-Alam 2013),BKSB beel of Khulna (Rahmanet al. 1999), Kaptai lake (Ahmed et al. 2001), Maljhee-Kangsa floodplain of Sherpur district (Ahmed et al. 2005), Dopibeel in Joanshahi Haor of Kishorgonj (Azhar et al. 2007), River Titas (Ahmed and Akhter, 2008), Titas floodplain (Ahmed 2008), and Mahananda River (Mohsin and Haque, 2009).

Table 1. Finfish and shellfish of the River Sangu.
Order, family, habitat preference (in brackets) and threatened status (IUCN 2000) are shown.

Finfish	47. *Heteropneustes fossilis*, (W), NO	87. *Stigmotigobius sadanundio*, (R, E), NO
Order 1. Anguilliformes	**Family 13. Pangasidae**	88. *Periopthalmodon schiosseri*, (E), NO
Family 1. Anguillidae	48. *Pangasius pangasius*, (W, E), CR	89. *Scartelaos histophorus*, (E), NO
1. *Anguilla bengalensis*, (MC), VU	**Family 14. Ariidae**	**Family 33. Gobioididae**
Family 2. Moringuidae	49. *Arius sagor*, (E), NR	90. *Taenioides cirratus*, (R, E), NO
2. *Moringua raitaborua*, (R, E), NO	**Family 15. Plotosidae**	91. *Odontamblyopus rubicundus*, (R, E), NO
Family 3. Muraenidae	50. *Plotosus canis*, (E, S), VU	**Family 34. Trypauchenidae**
3. *Gimnothorax tile*, (R, E), NO	**Family 16. Schilbeidae**	92. *Trypauchen vagina*, (E, C, S), NO
Family 4. Ophichthidae	51. *Ailia coila*, (R, K), NO	**Family 35. Sillaginidae**
4. *Pisodonophis boro*, (S, E, R), NO	52. *Clupisoma gaura*, (R), CR	93. *Sillaginopsis panijus*, (E, S), NO
Order 2. Clupeiformes	53. *Eutropiichthys murius*, (R), NO	94. *Sillago sihama*, (E, S), NR
Family 5. Clupeidae	54. *Eutropiichthys vacha*, (R), CR	**Family 36. Gerreidae**
5. *Tenualosa ilisha*, (S, E, R), NO	55. *Neotropius atherinoides*, (R), NO	95. *Gerres erythrourus*, (E, C), NR
6. *Gudusia chapra*, (W), NO	**Family 17. Siluridae**	**Family 37. Belontiidae**
7. *Corica soborna*, (W), NO	56. *Wallago attu*, (W), NO	96. *Colisa fasciatus*, (W), NO
Family 6. Engraulididea	57. *Ompok pabda*, (W), EN	97. *Trichogaster chuna*, (W), NO
8. *Coilia dussumieri*, (S, E), NO	**Family 18. Sisoridae**	**Family 38. Polynemidae**
9. *Setipinna phasa*, (R, E, K), NO	58. *Bagarius bagarius*, (R), CR	98. *Polynemus paradiseus*, (E), NO
10. *Setipinna taty*, (S, E), NO	59. *Gagata gagata*, (R), NO	**Family 39. Channidae**
Order 3. Osteoglossiformes	60. *Gagata youssoufi*, (R), NO	99. *Channa orientalis*, (FP, B), VU
Family 7. Notopteridae	**Order 6. Beloniformes**	100. *Channa punctatus*, (FP, B), NO
11. *Notopterus notopterus*, (P, L, B), VU	**Family 19. Hemirhamphidae**	101. *Channa striatus*, (FP, B), NO

Order 4. Cypriniformes	61. *Dermogenyes pussilus*, (W), EN	**Order 10. Mugiliformes**
Family 8. Cyprinidae	**Family 20. Belonidae**	**Family 40. Mugilidae**
12. *Labeo ariza*, (W), NR	62. *Xenentodon cancila*, (W), NO	102. *Sicamugil cascasia*, (R), NO
13. *Labeo calbasu*, (R), EN	**Order 7. Cyprinodontiformes**	103. *Rhinomugil corsula*, (E), NO
14. *Labeo gonius*, (R), EN	**Family 21. Aplocheilidae**	**Order 11. Scorpaeniformes**
15. *Labeo rohita*, (R), NO	63. *Aplocheilus panchax*, (W), NO	**Family 41. Platycephalidae**
16. *Labeo angra*, (R), NO	**Family 22. Adrianichthyidae**	104. *Platycephalus indicus*, (R, E), NO
17. *Catla catla*, (R), NO	64. *Oryzias dancena*, (TR, E), NR	**Order 12. Symbranchiformes**
18. *Cirrhinus mrigala*, (R), NO	**Order 8. Syngnatheformes**	**Family 42. Mastacembelidae**
19. *Cirrhinus reba*, (R, K), NO	**Family 23. Syngnathidae**	105. *Mastacembelus armatus*, (W), EN
20. *Aristichthys nobilis*, (R-Ex), NO	65. *Microphis cuncalus*, (R, E), NO	106. *Macrognathus puncalus*, (W), NO
21. *Hypothalmichthys molitrix*, (R-Ex), NO	**Order 9. Perciformes**	107. *Macrognathus aculeatus*, (W), NR
22. *Neolissochilus hexagonolepis*, (HS), DD	**Family 24. Centropomidae**	**Order 13. Pleuronectiformes**
23. *Barilius barna*,(HS), DD	66. *Lates calcarifer*, (C, E), NO	**Family 43. Soleidae**
24. *Barilius bendelisis*, (HS), EN	**Family 25. Ambassidae**	108. *Brachirus orientalis*, (R, E), NO
25. *Amblypharyngodon mola*, (W), NO	67. *Chanda nama*, (W), VU	**Family 44. Cynoglossidae**
26. *Chela laubuca*, (W), EN	68. *Parambassis ranga*, (W), VU	109. *Cynoglossus cynoglossus*, (R, E), NO
27. *Crossocheilus latius*, (R), EN	69. *Pseudambassis baculis*, (W), DD	**Shellfish**
28. *Osteobrama cotio*, (W), EN	**Family 26. Scatophagidae**	**Order 14. Decapoda**
29. *Puntius chola,* (W), NO	70. *Scatophagus argus*, (E, S), EN	**Family 45. Palaemonidae**
30. *Puntius sophore*, (W), NO	**Family 27. Sciaenidae**	110. *Macrobrachium rosenbergii*, (R, E), NR
31. *Puntius ticto*, (W), VU	71. *Johnius coitor*, (E, K), NO	111. *Macrobrachium villosimanus*, (R), NR
32. *Puntius gelius*, (W), DD	72. *Pama pama*, (E, S), NO	112. *Macrobrachium malcolmsonii*, (R, E), NR
33. *Puntius conchonius*, (W), NO	73. *Macrospinosa cuja*, (S, E, R, MA), NO	113. *Macrobrachium dolicodactylus*, (W), NR
34. *Rasbora rasbora*, (W), EN	**Family 28. Cichlidae**	114. *Macrobrachium dayanus*, (R), NR
35. *Securicula gora*, (W), NO	74. *Oreochromis niloticus*, (W-Ex), NO	115. *Macrobrachium rude*, (R, E), NR
36. *Salmostoma bacaila*, (W), NO	**Family 29. Anabantidae**	116. *Macrobrachium birmanicus*, (W), NR
37. *Salmostoma phulo*, (W), NO	75. *Anabus testudineus*, (P, B), NO	117. *Macrobrachium mirabilis*, (R, E), NR
Family 9. Cobititidae	**Family 30. Teraponidae**	118. *Palaemon styliferus*, (W, E), NR
38. *Lepidocephalus guntea*, (W), NO	76. *Terapon jarbua*, (E, S), NO	**Family 46. Penaeidae**
Order 5. Siluriformes	**Family 31. Eleotrididae**	119. *Metapenaeus monoceros*, (E, S), NR
Family 10. Bagridae	77. *Butis butis*, (E, S), NO	120. *Metapenaeus brevicornis*, (E, S), NR
39. *Sperata aor*, (W), VU	78. *Eleotris fusca*, (E, S), NO	121. *Metapenaeus dobsoni*, (E, S), NR
40. *Sperata seenghala*, (W), EN	**Family 32. Gobiidae**	122. *Metapenaeus lysianssa*, (S), NR
41. *Mysttus cavasius*, (W), VU	79. *Glossogobius giuris*, (W), NO	123. *Penaeus merguiensi*, (E, S), NR

42. *Mystus gulio*, (MA), DD	80. *Brachygobius nunus*, (R, E), NO	124. *Penaeus monodon*, (E, S), NR
43. *Mysttus vittatus*, (W), NO	81. *Awaous grammepomus*, (HS), NO	125. *Parapeanaeopsis sculptilis*, (S), NR
44. *Mystus tengara*, (W), EN	82. *Apocryptes bato*, (R, E), NO	**Family 47. Portunidae**
45. *Mystus bleekeri* (W), NO	83. *Pseudapocryptes elongatus*, (E, S), NR	126. *Potamon martensi*, (W), NR
Family 11. Claridae	84. *Paraapocryptes serperaster*, (E, S), NO	127. *Scylla serrata*, (E), NR
46. *Clarius batrachus*, (W), NO	85. *Oxyurichthys microlepis*, (E), DD	
Family 12. Heteropneustidae	86. *Ophieleotris aporos*, (R, E), NR	

Abbreviations: Habitat preference (B – Baor, Beel and Haor, C - Coastal water, E - Estuary, Ex – Exotic species, FP - Flood plain, HS - Hilly stream, K - Kaptai lake, MA - Migratory anadromus, MC - Migratory catadromus, P - Pond, R - River, S - Sea, TR - Tidal river, W - Wide freshwater). Threatened category (CR – Critically endangered, EN – Endangered, VU – Vulnerable, NO - Not threatened, NR - Not reported by IUCN 2000, DD - Data deficient)

Ahmed et al. (2013) recorded 50 species of finfish under 15 families from the hilly stream of Sangu River at Bandarban point. In the present study some more species were recorded but species like Mohasoal,*Tor putitora* recorded by Ahmed et al. (2013) was not found. However, the copper Mohasoal, *Neolissochilush exagonolepis* which was recorded in the present study was not found in the records of them and also in Halda (Azadi and Arshad-ul-Alam, 2013). Cat fish, *Silonia silondia* was also not found in the present study and the cat fishes, *Bagarius bagarius* and *Gagata youssoufi* were not found in the records of Ahmed et al. (2013).

In this study 109 finfish and 18 shell fish species (16 prawns and 2 crabs) recorded from Sangu River were higher than those of Halda River (83 fin fish, 10 shell fish) (Azadi and Arshad-Ul-Alam 2013), Hilly streams of Bangladesh (82 fin fish) including Sangu (50 fin fish) (Ahmed et al. 2013), Pagla river (75 finfish) (Zafar et al. 2007), Mahananda river (56 finfish) (Mohsin and Haque, 2009), Naaf River (98 fin fish) (Hossain et al. 2007), Irrawady river, Myanmar (79 finfish), Narmada, India (77 finfish), (De Silva et al. 2007). But the number of shell fish species in the river Naaf (23 prawns – Hossain et al. 2007) were higher than those of the river Sangu, which might be due to wide river mouth and salinity up to considerable distance in the lower river area which created more habitats. The species richness (127- fin fish 109 and shellfish 18) in the river Sangu is comparable to the vast wide and longer river Padma (110 finfish – Islam and Hossain 1983) as well with some larger river system of Asia and other parts of this planet. A few more species may be added to the present list if remote border areas of the river are taken into consideration in any future investigation.

River Sangu is a transboundary river. Its unique beauty attract tourist and creates lot of tourist spots at different areas of Bandarban. Due to more pressure of human population the Bandarban town is rapidly expanding. Many more hotels, motels and unplanned buildings and inhabitants at river banks are already made and more construction is going on without proper sewerage and treatment system. All the households and city waste products (liquid and solid) are directly released to the River Sangu through the different drainage points of the Bandarban town. During winter due to less water and highly reduced water depth in the upstream fishing is done indiscriminately and thus causing threat to the aquatic biodiversity and sustainable fish production. On the other side sewerage and municipality waste directly draining to the low depth shallow waters cause detrimental water pollution, creating health hazards for the aquatic organisms. To protect and conserve the fish and shellfish biodiversity of Sangu River following measures are suggested:

1. As the River Sangu is one of the five interlinked rivers of Chittagong River system so fishing in the Halda adjacent rivers like: Karnaphully, Sikalbahha, Chandkhali and Sangu river should be effectively banned during the peak spawning season of the fish from March to July. This regulation was suggested by Khan and Azadi (2006) and accepted and declared by the authority, but yet this regulation [(Bangladesh Gazette July 2, 2007, Peoples Republic of Bangladesh, Ministry Fisheries and Livestock (Fisheries Branch-2)] has not been implemented in the River Sangu and also in other four Halda linked rivers.
2. To protect and conserve the fish biodiversity, different detrimental gears like Gherajal (enclosure net), Catla jal (gill net), any mosquito net, lift net, Satki jal (cast net) and current jal (monofilament gill net) and all kinds of hooks and lines should be banned throughout the year.

3. Galda (*M. rosenbergii*) PL (post larvae) and juvenile collection and all brood prawn fishing should be banned during breeding season from February to July.
4. Declare four fish sanctuaries, two in upstream, one in mid and one in lower Sangu area, where dense human population are present. Primarily a fish sanctuary may be established from Bandarban town adjacent Balaghata to Kechingghat (about 6 kilometers).
5. In Sangu at Bandarban town point pollution (municipality liquid and solid wastes, septic tank black water and grey water directly coming to the Sangu) is increasing alarmingly. By declaring sanctuary nearby dense populated area pollution might be easily controlled and thus biodiversity will be sustained.
6. There should be alternative income generating activities and financial support for the dislodged fishermen due to conservation measures like ban of fishing during spawning season, restriction and ban of fishing gears, establishment of fish sanctuary etc.
7. Co-management institutions should be established to involve stakeholders of the community and other relevant agencies to help in implementing the proposed measures effectively.
8. Now Sangu river bank and the river near to Bandarban town is becoming the dumping place of all sorts'of waste materials produced by the dense inhabitants residing on the or nearby river bank. To protect and conserve the habitat, biodiversity and natural beauty of the River all unplanned inhabitants at river bank should be replaced in a planned area for keeping the river bank open and to keep the river free from pollution. Leasing of river bank should be banned and leased and occupied river bank should be revived and thereby keep free.
9. To protect the Sangu river before occurring any serious damage like highly polluted Buriganga River, immediate steps should be taken to build up the Sangu River with modern concept of 'Zero waste River'.
10. No industry should be allowed in the vicinity of the River Sangu without any treatment plant.
11. There should be a waste management programme by the Bandarban town authority. In all the private and public office, residence, and academic institutes there should be soak pits for the all septic tanks with proper engineering design. Thus direct releasing of all wastes to the Sangu River without treatment could be stopped.
12. Identify the migratory route of major carps and other species to further strengthen fish conservation.
13. Studies programme on fish stock assessment, spawning grounds, fish and shell fish biology, diversity of other aquatic living beings, water quality, fish species biodiversity and Jum cultivation nearby river bank should be undertaken.
14. Local awareness throughout length of the Sangu River and associated tributaries and adjacent rivers regarding benefit of fisheries regulation and control of pollution should be created using different electronic and printing media, leaflets, poster, rallies and meetings etc.

To conserve, protect, enhancing country's economy and livelihood of the community people, the finfish and shell fish and environment of the River Sangu, declared regulations (Bangladesh Gazette 2007) should be implemented effectively and pollution and illegal fishing should be stopped by the law enforcement agencies, regulations and by creating public awareness. Present records of 127 ichthyofauna (109 fin fishes and 18 shellfish species) will help the future researchers, planners and policy makers as no published account of ichthyofaunal diversity of Sangu River is available.

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Marine gastropods and bivalves of Saint Martin's Island in the Bay of Bengal

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Abstract

A taxonomic study on Gastropods and Bivalves of the Saint Marin's Island in the Bay of Bengal in Bangladesh was carried out from June, 2013 to October, 2014. Both live and dead samples were collected and identified on the basis of morphological characteristics and colour. The study resulted in identification of 45 gastropod species under 28 genera and 19 families of 4 orders. These included 2 families (Tonnidae and Turritellidae), 5 genera (Tonna, Turritella, Bufonaria, Cymia and Pupa) and 24 Gastropod species as new records for the Island. A total of 25 species of Bivalves were recorded. All the species belong to 4 orders, 12 families and 16genera. The dominant number of Bivalves were found under the order Veneroida (19 sp.) and the lowest number under the order Ostreina (1 sp.). There were 3 families (Cultellidae, Psammobiidae and Samelidae), 3 genuses (Siliqua, Asaphis and Semele) and 17 Bivalve species were newly enlisted in this island. Soil erosion, habitat destruction, unplanned tourism and over exploitation, are to be considered the main threats for the Gastropod and Bivalve fauna in St. Martin's Island.

Key words: *Bivalve, Gastropod, St. Martin's Island, Bay of Bengal*

Introduction

In general, marine gastropods and bivalves are most diverse in number of species and in variety of shell structures in tropical waters. The unique Island,the St. Martin's in Bangladesh is the only place that harbours coral colonies .This island has been facing an ecological disaster due to excessive Anthropological activities. The St. Martin's Island in 2005-06 in average was visited by 750 persons per day during a seven-month tourism season, which has increased to 1200 to 1500 persons per day recently. Although collection of shells as souvenirs by the tourists is prohibited by law but in reality almost every tourist is likely to carry some gastropods and bivalves that is posing threat to mollusks of the island. The Department of Environment (DOE), Bangladesh (1999) has declared the island as Ecologically Critical Area (ECA) to safeguard the environment.

The International Union for Conservation of Nature (IUCN) Red List has become an essential source of information for conservation action and is widely recognized as the most comprehensive compilation of extinct and threatened species (Mace & Lande 1991; Rodrigues et al. 2006). The IUCN Red List (2007) mentioned that Mollusks are the group most affected by extinction; despite the group having not been evaluated widely.

Many living species and dead materials in marine environments provide habitat for diverse molluscan communities. The quality of habitat is extremely variable and depends on habitat structural complexity and heterogeneity. For example, on rocky intertidal shores, provide habitats for extremely diverse assemblages of micro-mollusks and juvenile stages of larger species, many of which are of economic importance (Dye, 1992; Castilla & Defeo, 2001) and extracted by poor for livelihood. The mollusk habitat strongly influenced the local biodiversity and ecosystem performance (Jones et al. 1994, 1997).

The present study was undertaken to make a systematic survey on the marine gastropods and bivalves considering their biological importance in St. Martin Island of the Bay of Bengal.

Methods and Materials

Saint Martin's Island placed between 20˚34' and 20˚ 39' N latitude, and 92˚18' and 92˚ 21' E longitude in the northeastern part of the Bay of Bengal (Figure 1). The island (8 km^2) is almost plain land and 3.6 m above the mean sea level. The study period was from June, 2013 to October, 2014. In Saint Martin Island, three sites were selected for specimen collection. Site-1 is from Central Market to 2 km west-south of Uttarpara. This site is approximately 0.122 km^2 and sandy, rocky and sandy-rocky beach dominated. Site-2 is from Central Market to 1 km east-south of Uttarpara and is approximately 0.021 km^2 which consist of Sandy, rocky and sandy-rocky beach. Site-3 is from BDR Camp to 1.5 km South of Uttarpara and is

approximately 0.041 km^2 with rocky and sandy-rocky beach dominated. Mostly living and dead shells were collected from sites by hand picking using gloves. After washing them with water living and dead shells were separated and preserved. The specimens were identified mainly based on the shell morphology and colour in the Fisheries Lab. of the Department of Zoology, Jagannath University based on books written by Siddiqui et al. (2007) and Ahmed (1990).

Figure 1: Study sites of St. Martin's Island

Results and Discussion

From 600 collected specimens total of 45 gastropod species under 28 genera and 19 families of 4 orders and 25 bivalve species under 16 genera and 12 families of 4 orders were identified from the study area. Previously Ahmed (1990) described 98 gastropod and 15 bivalve species and MoEF (2001) recorded 105 gastropod and 27 bivalve species from this island. In total 41 species have never previously been reported from this coastline. A total of 19 families of gastropods are recorded in present investigation. Present recorded gastropod families are- Neritidae, Turbinidae and Trochidae under order Archaeogastropoda; Cypraeidae, Tonnidae, Strombidae, Turritellidae, Bursidae, Potamididae, Neticidae and Ranellidae under order Mesogastropoda; Muricidae, Fasciolariidae, Olividae, Buccinidae, Melongenidae, Marginellidae and Conidae under order Neogastropoda and Acteonidae under order Cephalaspidea. Ahmed (1990) recorded a total of 31 families and MoEF (2001b) recorded 40 families in the Saint Martin Island. A total of 12 families of bivalves were recorded in present investigation. Present recorded bivalve families are Arcidae under order Arcoidae; Mytilidae under order Mytiloida; Cardiidae, psammobiidae, Donacidae, Cultellidae, Mactridae, Tellinidae, Semelidae, Veneridae, Chamidae, under order Veneroida; Ostreidae under order Ostreina. Ahmed, (1990) recorded Pteriidae, Ostreidae, Mytiloida, Plicatulidae, Cardiidae, Tellinidae, Veneridae, Chamidae, Trapeziida, and Arcidae. Ahmed, (1990) recorded a total of 10 families and MoEF (2001b), recorded 12 families. In this study, 2 family (Tonnidae and Turritellidae), 5 genus (*Tonna, Turritella, Bufonaria, Cymia* and *Pupa*) and 24 species of class Gastropoda were newly recorded which are (*Trochuso chroleucus, Astralium stellar, Nerita amoena, Cypraea cheradia, C. caurica, C. staphylaea, C. corneola, C.eglantina, Tonna tessellata, Polinices duplicata, Turritella columnaris, T. duplicata, Cymatium nicobaricum, Bufonaria echinata, Chicoreus torrefactus, C. ramosus, Murex trapa, M. ternispina, Thais armigera, T. echinata, Cymia lacera, Pleuroploca glabra, Oliva reticulate* and *Pupa solidula).* Under the class Bivalvia, 3 family (Cultellidae, psammobiidae and Semelidae), 3 genus *(Siliqua, Asaphis* and *Semele*) and 17 species were newly recorded which are (*Scapharca pilula, Septifer bilocularis, Mactra violacea, M. achatina, Asaphis violacens, A. deflorata, Donax cuneatus, Siliqua radiate, Siliqua sp, Trachycardium muricatum, Gastrana abildgaardiana, G. pectinatum, Semele sp, Paphia gallus, Crassostrea virginica, Venus toreuma, Sunetta meroe*).

Coastal urbanization changes intertidal shorelines, by alteration and destruction of natural habitat that are likely to influence distribution and abundances of intertidal molluscs, which are very important determinants of structure of intertidal assemblages. Among recorded species, 18 gastropod were identified from sandy beach, 27 sp. from rocky

beach, 5 sp. from muddy, 9 sp. from sandy- rocky, 4 sp. from sandy- muddy, 9 sp. from both sandy and rocky, 2 sp. from both rocky and muddy beach and only 1 sp. from both sandy and sandy-muddy beach (Figure 2). There were 80% bivalve species (20 sp.) collected from sandy beach, 4 sp. from rocky and 2 sp. from sandy and rocky beach.

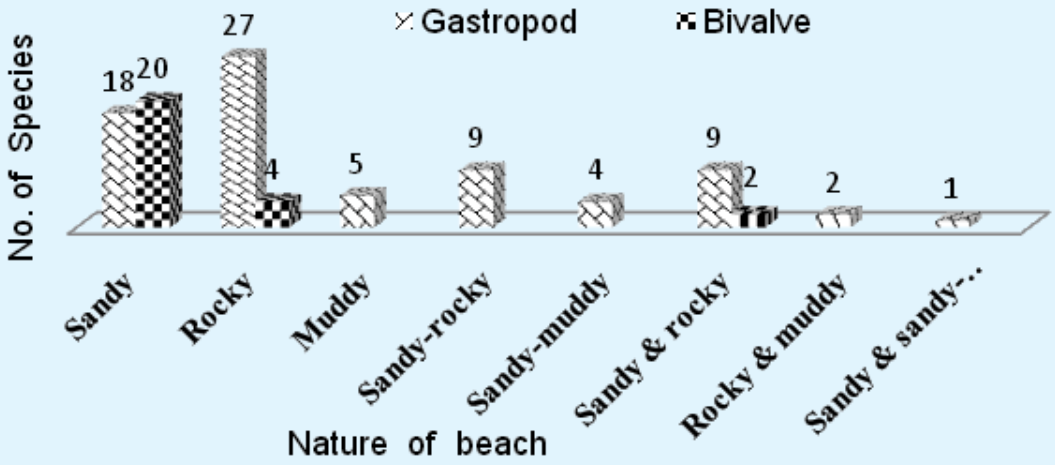

Figure 2: Abundance of gastropod species in different habitat.

The entire Island faces vast environmental threats by some physical infrastructures like land & housing development for tourist demand, erosion, and tourist pressure etc (Figure.3). Our study shows the need of improved public policies aiming the conservation of its marine fauna, as well as programs of environmental education to raise the awareness of local settlers regarding their island protect from destruction. We compared our data with previously recorded mollusk in this island by Ahmed (1990) and MoEF (2001) which are shown in Table 1. More than 35 collected shells were unidentified due to lack of literature and available information.

Figure 3: a. Tourist, b. Sea erosion, c. Land development and housing

Table 1: Occurrence (+) of collected gastropods and bivalves in Saint Martin Island in variation in comparison with other studies.

Conclusion

The identified species from the sample area could provide information for further protection and management of the mollusc resources of the Saint Martin's island.

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Genetic diversity and population structure of Hilsha Shad,Tenualosa ilisha populations in the Bay of Bengal revealed by the mitochondrial DNA sequencing

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Abstract

Hilsa Shad (Tenualosa ilisha) is the largest and single most valuable fishery in Bangladesh being distributed from Iran and Iraq in the Persian Gulf to the west coast of India in the Arabian Sea and the Bay of Bengal. The Government of Bangladesh has taken several measures for the conservation and management of the hilsa fishery to achieve sustainable production. Assessment of genetic diversity and population structure of the fish are essential for maintaining a productive fishery and effective conservation. The major objective of the study is to identify population genetic structure of *T. ilisha* with their genetic diversity in Bangladesh as well as the Bay of Bengal. The study also assesses the phylogeography and demographic history of the species in the studied region. A total of 63 individuals were collected from three sites located in Bangladesh and India. Partial sequences of mitochondrial DNA control region (D-loop) were analyzed to assess the genetic diversity, population genetic structure, phylogeography and historical demography of hilsa shad. A total of 331 polymorphic sites were found, and 54 haplotypes were defined. For all the populations, nucleotide diversities were low (0.07 – 0.08) in the mtDNA sequences whereas the haplotype diversities were as high as 0.98 to 1.00, indicating that the fish has undergone population expansion after bottleneck. The conventional population statistic FST, and exact test of population differentiation revealed low but significant genetic structuring between Bangladesh and India samples. Phylogeny of haplotypes revealed two genetically diverged groups of *T. ilisha* in the studied area. Neutrality tests such as Tajima's D and Fu's FS statistics and mismatch distribution analyses suggested that hilsa shad of the Bay of Bengal region has undergone the demographic history of population expansion during last glacial maxima approximately 7000 to 14000 years ago. Knowledge on genetic diversity and population structure will help to establish appropriate fishery management policy and conservation strategy for the species.

Key words: *Hilsa Shad, mtDNA, population, genetic diversity, Bangladesh, India*

Introduction

The national fish of Bangladesh, Hilsa Shad, *Tenualosa ilisha* (Clupeidae, Clupeiformes) is an anadromous species distributed from Kuwait, Iran and Iraq in the Persian Gulf to the west coast of India and Pakistan in the Arabian Sea and the India, Bangladesh, Myanmar and Thailand at the Bay of Bengal (Ahsan et al. 2014). Hilsa is the single most valuable fishery in Bangladesh and is also commercially very important in India, Myanmar, Pakistan and Kuwait. In Bangladesh, Hilsa contributes 50-60% of the global hilsa catch and 12-13% of the national fish production (BOBLME, 2008).In India, it accounts for 15-20% of the total fish landings of the Hooghly estuary (Mohantyet al, 2011).Different factors such ashydrological changes of spawning ground as well as overfishing, and habitat degradationare causing adverse effect on Hilsa production. Recently Bangladesh and India have made joint initiative for breeding and aquaculture of Hilsa to meet up the increasing demand (Puvanendran, 2013). The governments of both countries are also planning to make coordinated regional management strategy for conservation of Hilsa. Information on genetic variability and population structure of fish is very important for conservation, management and artificial propagation. Though few researches on the population genetic structure of T. ilisha have been conducted on morphometric, allozyme and RFLP analyses, the results were contradictory (Mazumder and Alam, 2009). In the present study, an effective marker, mtDNA control region sequence has been used for assessing genetic diversity, and population structure of Hilsa. The analyses will also provide insights into historical demography and evolutionary process of the species that might have influenced by paleoceanographic condition of the Bay of Bengal.

Materials and Methods

A total of 63Hilsa shad individuals were collected from three locations: two localities from Bangladesh i.e. Chandpur (CP) and Cox's Bazar (XP) and one from India (Ichapur, IP of West Bengal) in August and September, 2014. The individuals of CP and IP populations were collected when fish re¬turned to their natural rivers, Meghna and Hoogli, respectively for

breeding. Twenty one samples were collected from each of the three locations. Genomic DNA was extracted from the tissue of the 95% alcohol fixed specimens using a DNeasy blood and tissue kit (Qiagen, Germany) following the manufacturer's proto¬col. The first hyper variable portion of the mtDNA control region was amplified from the genomic DNA throughthe polymerase chain reaction (PCR) using the forward and reverse primers,TilsDL-F (5 –GAAAGGTTTTAACTTCCACCC–3) and TilsDL-R (5 –TAGTTCATTGCTC GGTTCTT–3). PCR was performed in a 50 µ reaction mixture containing 2.5 unit of Taq DNA polymerase, 5 µ of 10× PCR buffer, 10mM each of the dNTPs (2.5 µ each), 25 pmoles of each primer, and 0.5–1.0 µg template DNA. The temperature profile was as follows: preheating at 95°C for 2 min, followed by 35 cycles of denaturation at 95°C for 30 sec, annealing at 53°Cfor 40 sec, extension at 72°C for 1 min, and completion with final extension at 72°C for 5 min. PCR products were examined by 1% agarose-gelelectrophoresis with a standard size marker and purified by a PCR purification kit (Takara, Japan). The purified DNA was sequenced using Automated DNA sequencer 377 or 3100 (Applied Biosystems, USA).

The sequence data were edited and aligned withClustalW (Thomp¬son et al. 1994). Molecular diversity indices such as haplotype diversity (h), nucleotide diversity ( ), average number of nucleotide differences (k), number of haplotypes (Nh), polymorphic sites (S), transitions (ti) and transversions (tv) for each population using the program ARLEQUIN (version 3.5, Schneider et al. 2000). Pairwise population genetic structure (i.e. fixation index, FST) and population panmixia (i.e. exact test) among populations; and hierarchical analysis of molecular variance (AMOVA) were also assessed using ARLEQUIN. The program MEGA 3.1 (Kumar et al. 2004) was used for reconstructing phylogenetic relationship among haplotypes of the d-loop sequences by neighbor-joining (NJ) method (Saitou and Nei 1987). Historical demography of the T. ilishawas examined by Tajima's D statistics, Fu's FS test for selective neutrality; and mismatch distribution (MMD) analyses implemented in ARLEQIN. In MMD, historic demographic expansion was represented by three population genetic parameters: (tau, an index of time since expansion expressed in units of mutational time), 0 and 1 (mutational parameters of population size represent the population sizes before and after the expansion, respectively; Rogers 1995). The mutational time value of was converted into estimate of real time in years since expansion with the equation, = 2ut, in which u is the mutation rate for the whole sequence and t is the time measured in generation since expansion. Mutation rate is required to convert the mutational time value of expansion ( ) to real time in years. Divergence rate of 5 – 10% per million years (MY) was used for the D-loop region in the present study as used for fish in other studies (Han et al. 2008).

Results and Discussion

Intra-specific genetic diversity

A total of 623 nucleotide long D-loop region were obtained from 63 individuals of three populationsXP, CP and IP after removing the ambiguous sequences near the primer ends.Thesequences comprised 331 polymorphic sites. These polymorphic sites defined 54 haplotypes, of which 48 haplotypes were singletons, two haplotypes were shared between two populations and four haplotypes were found in more than one individual, but in only one population. Most of the nucleotide substitutions were transitional (Table 2) and 279 indels were detected in the sequences of D-loop region. The nucleotide diversities ( )were very low in each sample,0.07-0.08 nucleotide differences per site while the haplotype diversities (h) were very high, 0.98-1.00(Table 1). Several scenarios have been proposed to explain the maintenance of high haplotypic diversity within populations of an organism, including large population size, environmental heterogeneity, and life history traits that favor rapid population increase (Nei 1987). In marine fishes, large population size is considered to be responsible for extraordinarily high levels of genetic diversity (Avise 1998). Hilsa shad occurs in the foreshore areas, estuaries, brackish water lakes and freshwater rivers of the western division of the Indo-Pacific faunistic region. Its marine distribution extends from Kuwait, Iran and Iraq in the Persian Gulf to the west coast of India in the Arabian Sea, the Bay of Bengal to northern Sumatra. Such large population size may account for the high levels of haplotypic diversity observed for *T. ilisha* in this study. High haplotypic diversity suggests large, stable, effective population size over time in the continental shelf fishes (Stepien 1999) as well as Hilsa shad. High haplotypic diversity with low nucleotide diversity in the mtDNA control region of *T. ilisha* might imply that the population experienced expansion after the bottleneck (Slatkin 1993).

Table 1. Genetic diversities of the D-loop region of three populations of *T. ilisha*

Population (ID)	N_h	N_h/N_i	Substituitions [ti + tv]	*h*		S	*k*
Cox's Bazar (XP)	21	1.00	45 [41+4]	1.00	0.08	190	50.20
Chandpur (CP)	18	0.86	42 [35+7]	0.98	0.07	228	43.07
Ichapur, (IP)	17	0.81	43 [39+4]	0.98	0.08	181	50.11
Pooled	54	0.86	83 [70+13]	0.99	0.08	331	50.33

* Number of samples (N_i), number of haplotypes (N_h), haplotype diversity ***(h)***, Substitutions (transitions, ti + transversions, tv), nucleotide diversity ( ), number of polymorphic sites (S), average pairwise differences among haplotypes ***(k)***.

Population genetic structure

Pairwise comparisons of FST indicated small but significant genetic differentiation only between IP and CP with the value of 0.019 (P = 0.01) (Table 2). Exact test of population differentiation also showed significant difference with the P values of 0.02 between these two populations (IP and CP). These results strongly suggest non-panmictic mtDNA gene pool for T. ilisha throughout its examined range. Most marine fishes exhibit high level of gene flow and poor intra-specific genetic structure over large geographic distance due to lack of physical barriers in the ocean, long distance dispersal of eggs and larvae by ocean currents and/or migration of adults (Palumbi 1994; Waples 1998). There are a number of exceptions which resulted from philopatric behavior, local larval retention (Hewitt 2000). In the present study, CP and IP populations were the spent or brood fish collected in breeding season from their natal rivers, Meghna and Hugli. The philopatry (tendency of organism to breed at or near their place of birth) possibly caused the significant genetic separation between them. On the other hand, the individuals of XP population were collected from the open sea. So, this population likely consists of both the fishes from CP and IP population and did not show significant genetic differentiation from those river populations.

Table 2. Pairwise FST (Fixation index) and Exact P values (Exact test) among populations of H. agrammus for mtDNA control region

Population (ID)	Pairwise FST			Exact P values		
	XP	CP	IP	XP	CP	IP
Cox's Bazar (XP)	–			–		
Chandpur (CP)	0.003	–		0.35	–	
Ichapur (IP)	0.012	*0.019	–	0.07	0.02	–

*P = 0.01

In AMOVA, no significant grouping (i.e. significant Φ_{CT} values) were obtained when the three populations were divided into different groups such as India (IP) vs. Bangladesh (CP + XP) grouping or other two different combinations i.e. CP vs. IP + XP or XP vs. CP + IP group.

Phylogeny and demographic history

The neighbor-joining (NJ) tree (Figure: 3) showed two distinct lineages (A and B) of haplotypes, which were supported by high bootstrap values.However, there was no clear geographical association in the distribution of haplotypes. Lineage A was comprised of 38haplotypes, while the 16 haplotypes in lineage B were found.

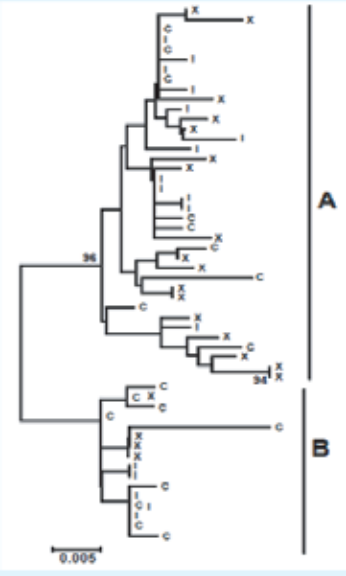

Figure 1. A Neighbor-Joining tree of D-loop haplotypes of *T. ilisha*. Bootstrap supports of more than 90% in 1000 replicates are shown. Letter symbols represent geographical distribution of each haplotype [C- CP; X- XP; I- IP].

Table 3. Tajimas'sD andFu's FS statistics, and mismatch distribution parameter estimates (τ, θ_0, θ_1).

Population	Tajima's D		Fu's FS	Mismatch distribution			
	D	P	FS	P	τ	θ_0	θ_1
XP	–0.54	0.32	–3.68	0.04	49.96	0.00	101.41
CP	–0.66	0.28	–0.13	0.46	0.04	45.96	99999.00
IP	–1.09	0.13	–1.25	0.71	39.09	21.47	101.38
Pooled	–1.42	0.05	–8.96	0.03	43.94	11.09	88.77

In the neutrality tests, both of Tajima's D and Fu's FS statistics (Table 4) for CP and IP populations showed negative valuesbut those were not in significant level(D = –0.66 and –1.09, P>0.05; FS = –0.13 and –1.25, P>0.05 for CP and IP, respectively) indicating demographic equilibrium of these populations. For the XP population,negative and non-significant Tajima's D value (D = –0.54 P = 0.32) with significantly small negative Fu'sFsvalue(FS = –3.68; P<0.05) also suggest the history of demographic equilibrium. However, neutrality test statisticsfor the pooled samplesshowed significantly negative values (D = –1.42 P = 0.05; FS = –8.96P<0.05) indicatinghistory of demographic expansion of the samples as a whole.

Figure 2.The observed pairwise difference (bar) and the expected mismatch distribution under the sudden expansion model (solid line) for CP, XP and IP populations of *T. ilisha*

Mismatch distributions of the sequences were all multimodal for each of the populations (Figure: 2) further suggesting the populations have been at demographic equilibrium and subdivided into several units (Excoffier, 2004). The demographic expansion times of the populations were estimated as the mutational time in generation from the mismatch distribution. The overall population expansion time could be calculated from the values for the pooled samples which was 43.94 (Table: 3). The values were then converted into the time in years since expansion according to the equation = 2ut and the divergence rates of 5–10% per MY for control region of fish, which resulted in the expansion times of approximately 0.7 to 1.4 MY ago at the middle to late Pleistocene period for the entire populations.The middle to late Pleistocene period(the past one million years ago) was attributed by a series of large glacial–interglacial changes with approximately 100,000 year intervals (Imbrie et al. 1992). This cyclic repetition of glaciation and deglaciation made great effect on the demography of marine fishes by provoking displacement, eradication, recolonization and expansion of populations (Hewitt 2000). Expansion of Hilsa shad during 0.7 to 1.4 MY ago also might be the effect of Pleistocene paleoclimatic changes. A number of pelagic fishes also show population expansion during the Middle to Late Pleistocene such as small yellow croaker (Xiao et al. 2009), Japanese anchovy (Liu et al. 2006), SardineSardinapilchardus (Atarhouch et al., 2006) and Pacific sardine S. sagax(Lecomte et al., 2004).

Assessment of genetic diversity and population genetic structure are essential for maintaining a productive fishery through effective management (Seeb et al. 1990). Different populations with unique genetic structure and/or geographically isolated stock should be managed as distinct units, and such units require separate monitoring and management (Salgueiro et al. 2003). Our study of mtDNA variations in spotty belly greenling showed evidence for low genetic subdivision in the Bay of Bengal region. However, for comprehensive understanding of genetic differentiation of the species, it is necessary to study more samples collecting from other locations of Bangladesh, Irrawaddi river of Myanmar which we are planning to accomplish in our lab.

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Theme 1: Abstracts

Wildlife Diversity in Bangladesh:
40 Years of Research and Conservation

The confirmed record of pouched Tomb Bat (*Saccolaimus saccolaimus*) in Bangladesh with notes on morphometry

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Abstract
Pouched Tomb Bat (*Saccolaimus saccolaimus*) is a widespread species in South and Southeast Asia, Malaysia, Indonesia and Australia. Khan (1982, 2001) mentioned this species as very common and widely distributed in Bangladesh. IUCN-Bangladesh (2000) denoted this species as Data Deficient. However, none of the previous checklists included this species were based on any voucher specimen, photographic evidences or any other documents that could prove the occurrence of this species in Bangladesh. This is the first confirm record of *Saccolaimus saccolaimus* in Bangladesh with a voucher specimen and photographs. As a part of regular mammal survey, a colony of S. saccolaimus with 46 individuals was found in Jahangirnagar University Campus, Savar, Dhaka. Five individuals were captured by using mist net, took necessary morphometric measurements and released them to the same habitat. Head-body length ranged from 87.55 – 90.40 mm with the mean 88.56 ±5.75 mm. Fore arm, Ear and Tail length varied from 68.16 -72.02 mm, 12.73-14.49 mm, 26.51-27.95 mm with the mean of 69.44 ±3.42 mm, 13.72 ± 0.74 mm and 27.06 ±3.13 mm respectively.

Habitat specific environmental settings and Anuran communities in Lawachara National Park

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Abstract
Tropical forests are diverse ecosystems with many endangered species. Changes in both global and micro climate have been pushing many forest dwelling organisms to extinction. This study focused on anuran communities of a critical protected area (i.e. Lawachara National Park) in Bangladesh. Here, the aim is to quantify the influences of environmental variables on anuran distribution. Anuran species and environment data were recorded following Visual Encounter Survey along with transect line method from 102 transects. Multivariate Redundancy Analysis (RDA) was performed to analyse the effects of environmental variables on anuran species composition. RDA was performed for the whole forest area as well as for three specific habitat types i.e. old growth, mixed and mono forest habitat. Beta diversity was estimated to quantify compositional heterogeneity across habitat types. Recorded total of 15 forest floor anuran species were recorded. Old growth forest floor was the most species rich habitat type. Beta diversity result showed no significant difference in anuran species composition among three habitat types. When analyzing pooled transects, RDA using environmental variables as predictors of the anuran assemblage explained 19.3% of the variance and canopy openness and bushy area coverage strongly influenced the species assemblage. In old growth forest, RDA explained 54.94%, in mixed forest 47.317%, in mono forest habitat 45.668%. Altitude was the strongest gradient for old growth, tree density for mixed forest, and tree size for mono forest habitat. The results of anuran community composition across different habitats under habitat specific environmental settings can help the government and conservation agencies in preparing pragmatic conservation plans and also implementing conservation actions efficiently.

Amphibian assemblages at Khadimnagar National Park, Bangladesh

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Abstract
Despite the location in a hot spot, no research work has been conducted on amphibians of Khadimnagar National Park (KNP) before and after its current status as a protected area in Bangladesh. An activity search survey for amphibians has been conducted by walking through 51 transects and amphibians encountered were recorded. Twelve anuran species belonging to 6 families and 11 genera were recorded during the study. *Euphlyctis cyanophlyctis* was the most abundant, with 232 individuals representing 51.7%; followed by *Fejervarya sp*., 85 individuals (18.9%) and the remaining 10 species altogether recording less than 30% (ranging from 2 to 34 individuals) of the total abundance. *Duttaphrynus melanostictus*, *Kaloula pulchra* and *Raorchestes parvulus* in particular occurred with very low abundance with five, three and two individuals respectively. Habitat types did not affect the abundance of the amphibians in the study area meaning that other factors rather than habitat disturbance may account for the low abundance of the amphibians in the KNP. Though the Park can recover its full amphibian assemblages some unknown threats can jeopardize any hope for recovery.

The importance of environmental heterogeneity for species diversity and assemblage structure of stream frogs at Lawachara National Park

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Abstract
Abiotic environmental factors and biotic processes are often favored to explain the structure of community assemblages. Several studies identified environmental factors to be an important one. Environmental heterogeneity influencing the species richness and composition of frog assemblages are investigated at forest streams in Lawachara National Park to determine whether this assemblage attributes can be influenced. For stream frog community, Lawachara National Park is dominated by *Euphlyctis cyanophlyctis* species. Canonical correspondence analysis (CCA) suggests species are responding to combination of environmental variables rather than any specific variable. CCA results also explaining that canopy openness and temperature is the most influential environmental gradient for *Euphlyctis cyanophlyctis* and *Hylarana leptoglossa* species. Soil type and human interference are influential for *Leptobrachium smiti* and *Fejervarya spp*. Canopy openness is the most influential gradient among all variables but it also can not define any structure for stream frogs as diversity indices are suggesting no significance difference in species composition. This study result can be useful for further research and may be done based on specific variable or species and also at different special scales. It will benefit conserve suitable habitat for most amphibians in a time of widespread declining of this animal class.

Sea grasses from Northeastern Coast of Bay of Bengal, Indian Ocean: Five New Global Records and Ecological Aspects

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Abstract
The coastlines of Bay of Bengal are highly productive in terms of nutrient input, which promotes the coastal living resources. These coastal areas comprised of variety of aquatic macrophytes i.e., seagrass which grow in the intertidal and littoral zone. The coastlines and estuarine coastal water logged areas of Bay of Bengal harbor at least five species of sea grass; *Halodule univervis, Halophila decipiens, Halophila beccarii, Ruppia maritima, Halophila pinifolia* among which the earlier two i.e., *H. univervis* and *H. decipiens* were reported nationally, but not globally. Sea grass, *H. beccarii* was found in the intertidal area and riversides which is co-existing with mangroves (*Avicennia alba* and *A. marina*), salt marsh grass, and scattered sparsely in the estuarine habitat with macro-algae *Ulva intestinalis*. Seagrass *R. maritima* was recorded in the aquaculture ponds and water logged areas while *H. pinifolia* was found patchily in the sandy area of Saint Martin's coral bearing reef at the south tips of the country near Myanmar. The ecological, morphological and ecosystem significant of these seagrasses were discussed and assessed. The future research activities and strategic approaches are needed to conserve and manage these important resources in the coastal area of Bay of Bengal.

Bodymass estimation of three snake species based on their morphological traits in Lawachara National Park, Bangladesh

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Abstract
Lawachara National Park (LNP) is one of the richest forests in Bangladesh for biodiversity. A study was conducted to predict the body mass of three abundant snakes *Amphiesma stolatum, Xenochrophis piscator* and *Enhydris enhydris* from three morphological traits snout-vent length (SVL), tail length and sex by constructing a linear model with the best combination of these. For *Amphiesma stolatum* consideration of both tail length and sex gave the best combination and for *Xenochrophis piscator* and *Enhydris enhydris* combination of SVL and tail length gave significant result. Later two models for each species, additive and interactive were constructed and tested against each other. Additive model appeared significant for *Amphiesma stolatum*, but for *Xenochrophis piscator* and *Enhydris enhydris* interactive model showed the best fitness for predicting body mass. Accurate estimation of biomass for a definite ecosystem can help the forest managers to identify key zones and take conservative strategies

Some aspects of behavioral ecology of captive Spotted deer *Axis axis* (Erxleben, 1777)

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Abstract
The present study was designed to know and provide thorough understanding the diurnal activity budget, behavior patterns, feeding and social behavior of captive spotted deer *Axis axis* (Erxleben, 1777) at Dhaka Zoo from April 2011 to November 2011. During the intensive study, a total of 27 (5 males, 19 females and 3 fawns) deer were observed for 18 days (2-3 days/month) in an enclosure (154×462 ft.) using scan and ad libitum sampling methods. All-occurrence sampling method was also used opportunistically to document behavior patterns of the deer. They spent most of time in resting (40.94%) followed by feeding (29.46%), standing (17.47%), walking (9.73%), performing social activities (1.99%), and running (0.37%). All these activities varied significantly between hours of the day (2= 156.8329, df= 11, P> 0.05), months (2= 843.287, df= 4, P> 0.05), and age-sex classes (2= 135.96, df= 2, P> 0.05). Spearman rank-correlation tests showed strong negative correlation between feeding and resting (r=0.99, P= 1.57) and feeding and walking (r= 0.94, P= 0.015). Feeding activities were concentrated in the morning (36.84%) and evening (31.57%). Diet mostly included bran of wheat *Triticum aestivum*, seasonal vegetables, fruits like *Musa sapientum* and green grasses e.g., *Zea mays, Amaranthus gangeticus, Spinacea oleracea*, etc. A total of 57 behavior patterns on essential maintenance behavior, social encounters and interactions with environment were recorded, of which 41 behavior patterns were similar for males and females and 16 behaviors showing significant sex differences. Captive farming has been conducted to conserve the wild population and utilize the wildlife. For better management and conservation of this species, a thorough understanding of behavioral characteristics is required.

Diversity pattern of Odonata in the North-east region of Bangladesh

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Abstract
Dragonflies and damselflies collectively known as Odonates are an important component of aquatic ecosystems. In current research, a study on diversity of odonata was carried out in the northeast region of Bangladesh from March 2014 to November 2014. Diversity of odonata were recorded from Shahjalal University of Science and Technology (SUST) campus,Tilagor Eco-Park), Lawachara National Park Satchari National park and Rajkandi Reserve forest. A total of 62 species of odonates belonging to the eighteen (34) genera under four (7) families were recorded . Among them 37 dragonflies under three (3) families and twenty five (25) damselflies under four (4) families were documented. The highest numbers of odonates (46 species) were recorded from Tilagor Eco-Park. Libellulidae was the predominant dragonfly family with thirty one (31) species whereas Coenagrionaidae was the prime damselfly family with sixteen (16) species. Among the recorded species Green Marsh Hawk (*Orthetrumsabina Sabina*) was the most abundant dragonfly.

Population structure and ranging patterns of Hanuman Langur (*Semnopithecus entellus*) in Jessore, Bangladesh

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Abstract
A study was conducted on the population structure of Hanuman langurs (*Semnopithecus entellus*) in Keshabpur and Monirumpur thana of Jessore district between April 2008 and February 2009. Survey data were collected using the direct observation technique. Initially, local residents were consulted to locate the group. When a group was found demographic data were collected. Total individuals in a group were confirmed by repeating the counts during different times of the day and month. Changes in demographics including group size and composition were recorded in each month. Daily movement of the groups was tracked by using GPS. Home ranges of the groups were calculated by summing all the day ranges of the particular group during the study period. A total of 8 groups with 154 individuals were recorded. Group size varied from 5 to 29 with the mean 19.25 ± 9.11 (n=8). The ratios of adult male to adult female (1:2.4), adult female to infant (1:0.43) and adult to immature (1:1.06) were calculated. Home range of these groups varied from 18.8ha to 91.1ha (mean = 56.72, sd ± 23.31, n=8) and the day range varied from 826m to 1128m (mean = 968, sd ±111.05, n=8). Infant or immature mortality in this population was very high (77%), the factors associated with this should be further researched.

A Study on the utilization of Indigenous and exotic species of plants by the Avifauna at Ramna Park, Dhaka

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Abstract
The role of avifauna as a significant element of ecosystem is undeniable. Now-a-days, plantation programme has taken as a mode of conservation initiative, where both native and exotic plants are being used. This study was conducted to assess the pattern of utilization of indigenous and exotic plants by the avifauna and to determine the suitability of plantation of exotic plants besides the indigenous plants from June, 2013 to May 2014 at Ramna Park, Dhaka. Observation of the utilization of plant species by the avifauna was based on five distinct activities, namely feeding, nesting, mating, rearing (of offspring) and roosting. It was found that in case of feeding, utilization on a combination of indigenous and exotic plant species was found in 48% of the observations, followed by exclusively indigenous species (28%) and exclusively exotic species (24%). For nesting, birds used indigenous plants more (50%) over exotic plants (30%) while utilization on combination of both types of plants was also found (20%). In case of mating, birds were found to mate on indigenous plants (67%) mostly rather than on exotic plants (33%), while utilization on indigenous plants (50%) and exotic plants (50%) were balanced in case of rearing of the young. For roosting, utilization on combination of indigenous and exotic plant species was found in 48%, where 31% in indigenous species and 21% in exotic species. The study found preferences on indigenous plant species by the avifauna in an urban setup. The findings, thus, have a significant role in selecting the suitable tree species during plantation programmes directed towards the conservation of avifauna and biodiversity as well.

The whitefly *Bemisia tabaci* manipulates its Endosymbiont quantity governed by host plant

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Abstract
The whitefly, *Bemisia tabaci* (*Hemiptera: Aleyrodidae*) is a sibling species group in which most species are substantially notorious pests of most horticultural and broad leaf agronomic crops around the globe. Previously, it was documented that *B. tabaci* hosts one primary endosymbiont and seven secondary endosymbionts. The primary endosymbiont functions to supply the required nutritional deficit to their host. Secondary endosymbionts, however, affect the fitness of their host, resistance to parasitoids, transmission of viruses and so on, even though their specific functions still unexplored. The objective of this study is if there any changes among the endosymbionts when reared their host insects on different plant species. To satisfy the objective, we analyzed the endosymbionts of B. tabaci biotype B qualitatively and quantitatively. We established three different laboratory whitefly populations of the same genetic background through rearing several generations on eggplant, tomato and cucumber namely, Bemisia-eggplant, Bemisia-tomato and Bemisia-cucumber, respectively. We transferred whitefly adults from natal host plant to new host plant, reared them from egg to adult eclosion, and quantified their endosymbionts. The amino acid compositions in host plants and whitefly populations were measured to determine if there is a relationship between the quantity of primary endosymbiont and plant nutrition. PCR results showed that host plant affects the endosymbionts quantitatively but not qualitatively. This suggesting that the loss or acquisition of endosymbionts may not occur due to the host plants affect. The quantity of primary endosymbiont increased or decreased based on the low or high composition of essential amino acids in the host plant. This suggesting that host insects may manipulate their endosymbiont quantity to satisfy their nutritional deficit. The information attained from this study will stimulate research interest on the associations among symbionts, insects, and plants.

Diurnal activity pattern of Asian Pied Starling *Sturnus contra* (Linnaeus, 1758) in Jahangirnagar University campus, Bangladesh

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Abstract
The diurnal activity pattern of Asian Pied Starling *Sturnus contra* was studied at Jahangirnagar University campus from January 2011 to November 2011 by using scan sampling method at five minutes interval. The scoring (n=9,581) revealed that the Asian Pied Starling spent most of time in foraging (36.53%) followed by resting (11.5%), flying (10.43%), performing breeding activity (9.87%), walking (9.4%), calling (9.4), preening (6%), wing flapping (5.22%), interaction with others (1.05%) and bathing (0.63%). The diurnal activity of Asian Pied Starling showed a wide variation in the months and also in different hours of the day. They started their diurnal activities as soon as the sunrise (n=6) when the light intensity was not so high, and stopped slightly before the sunset (n=18). Foraging, walking, and flying were most during the first half of the day with peak at 0800h. Breeding activity was found from January to July with highest (28%) in May. Highest calling activity was recorded in February (13.83%). Spearman rank-correlation tests showed that, foraging activity was positively (r= 0.914, P= 1.123) related with movement (walking and flying) and negatively (r= -0.83, P= 0.000391) related with resting. Preening activity was positively (r= 0.97, P= 5.93) related with resting. Preliminary findings on diurnal activity pattern can provide a foundation for further studying on the ecological, behavioral and physiological aspects of the birds as well as the management and conservation purposes.

Anuran biodiversity in Bangladesh: What next?

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Abstract
Bangladesh consists predominantly low plains comprising the Ganges-Brahmaputra River delta, one of the world's largest deltas, and lacks high mountainous regions. Despite its simple topographic feature, mitochondrial DNA gene sequences analyses revealed a rich cryptic biodiversity of this country and now recognized a hots pot for amphibian diversity, particular note with the evidence of increases frog species number from 22 to 37 between the year of 2000 and 2014. The contribution of DNA bar coding technique give a new scaffold to assign new species which are morphologically looks like similar but genetically distinct. In combination with molecular data, morphological and/or acoustic data also infer the new lineage. Consequently, the paucity of up-to-date anuran check list of this country is minimizing steadily. However, more exclusive sampling and molecular studies needed to reveal the hitherto overlooked cryptic biodiversity as well as need to establish in-situ and/or ex-situ conservation immediately for protecting the threatened species in Bangladesh.

Feeding ecology of Hanuman langur (*Semnopithecus entellus* Dufresne, 1797) in Jessore, Bangladesh: Dietary composition, seasonal and age-sex differences

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Abstract
The feeding behavior of Hanuman langurs (*Semnopithecus entellus*) was studied from September, 2012 to August, 2013 in Jessore, Bangladesh. The study was based on direct observation from dawn to dusk and data was collected using focal animal sampling. The results showed that they were largely folivorous, fruits and other items were actively sought out when available. Identified total of 54 plant species were identified in the diet (33 tree species, 8 shrubs and 13 herbs). The greatest amount of time was spent feeding on leaves (57.6%) followed by fruits (20.1%), buds (6.9%), flowers (3.6%) and bark (0.4% of time spent). Langurs also consumed provisioned food (10.4%), and non-plant food items including soil, water and fungi (1.0% of time spent). The number of different plant species utilized for food varied seasonally. Langurs utilized a greater number of plant species in winter (49 spp.) and summer (48 spp.) than in the rainy season (37 spp.). Plant food consumption did not vary significantly by age class, but adults utilized slightly more plant species (53 plant species) than did immatures (48 plant species). Time spent feeding on natural foods significantly differed between adult males and adult females while no sex difference between immatures was detected. This highest amount of time was allocated to feeding in the early morning and the lowest at mid-day, regardless of season. Time spent feeding did not significantly fluctuate seasonally. As they are good indicators of the general health of the ecosystem and special attention to them is required for proper conservation planning. By this study we now know that the diversification of their feeding habit, is important for any conservation plan of this species within these habitats.

Effect of bio-rational substance Neem (*Azadirachta indica* A. Juss) oil cake on different developmental stages of *Culex quinquefasciatus* say

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Abstract
Efficacy of Neem (*Azadirachta indica*) oil cake on oviposition behaviour of adult mosquito, *Culex quinquefasciatus* was observed. The effect of Neem oil cake was also observed against egg rafts, pupal transformation, adult emergence and different larval instars (1st, 2nd, 3rd and 4th). This research work estimated the effect of Neem oil cake (1gm Neem oil cake properly mixed in 1 litre test media and 2gm Neem oil cake properly mixed in 1 litre test media), as an oviposition attractant media for *Culex quinquefasciatus*. The test media were straw infused water and tap water mixed with Neem oil cake, normal straw infused water and tap water without Neem oil cake. Varying degrees of results were obtained among the different media and doses. Comparatively high numbers of egg rafts were laid on straw infused and tap water with Neem oil cake (% Mean 8.95, 9.47; 12.89, 7.99) than straw infused and tap water without Neem oil cake. There were no significant differences between two doses and the test media. Egg rafts were damaged in straw infused water mixed with Neem oil cake (1gm/l, % Mean 12.21 and at 2gm/l, % Mean 15.14). The result did not vary significantly with tap water mixed with Neem oil cake at 1gm/l, but varied significantly at 2gm/l dose. In both the doses and test media (1 gm/l, 2 gm/l) pupal transformation was suppressed, but no significant variation was observed with straw infused and tap water mixed with Neem oil cake. Similar results were observed in adult emergence also. Neem oil cake exhibited growth regulatory effect on larvae and pupae. Four different doses (0.10gm/l, 0.50 gm/l, 1 gm/l and 2 gm/l) of Neem oil cake were also observed against laboratory reared different larval instar (1st, 2nd, 3rd, and 4th). All four instar of larvae were highly susceptible (100 % Mean mortality) at these doses (1gm/l and 2gm/l). The 1st instar larvae showed least resistance to 0.10 gm/l Neem oil cake. At dose 0.50 gm/l % mean mortality of 1st, 2nd, 3rd and 4th instar larvae were 80, 78, 70 and 60 respectively.

Phylogenetic position of *Zakerana asmati*: evidence from mitochondrial 12S and 16S genes sequences

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Abstract
Phylogenetic position of the *Zakerana asmati* has remained unconfirmed since it was discovered in 2011 based on morphology. We investigated its phylogenetic position with mitochondrial (mt) genes by comparisons to all other known species in the genus Zakerana and also other species of its sister genus Fejervarya. Ten individuals of were collected from the type locality (Chittagong University campus) for the sequencing of 12S and 16S mt genes. The nucleotide sequences of the 16S and 12S genes were separately aligned with available sequences from Gene Bank (N=20). From these two alignment data sets, sequence divergences (uncorrected p-values) were calculated using Kimura 2-parameter model with the pairwise-deletion option, in which all aligned sites were used for calibration, but indel sites were not included. The phylogenetic analysis was done using each gene fragment separately, as well as utilizing the combined dataset. The combined dataset comprised of 756 bp (407 bp for 16S and 349 bp for 12S) to be used in further phylogenetic analyses performed using maximum likelihood (ML) and Bayesian inference methods. The GTR + I + G substitution model was the most fitting nucleotide substitution model for the combined dataset. Maximum parsimony and Bayesian posterior probability methods resulted in similar phylogenetic trees with strongly supported clade for *Z. asmati*. The new species also showed high genetic divergence from all the other congeners of the genus Zakerana. The sequence divergences between *Z. asmati* and other species were significant, ranging from 9 – 18.7% for 12S rRNA, and from 7.3 – 14.2 % for 16S rRNA. The phylogenetic trees based on individual genes and the combined data suggested that *Z. asmati* is sister to *Z. pierrei* and *Z. granosa*.

Amphibian diversity in Teknaf Nature Park, Bangladesh

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Abstract
A study was conducted on amphibian species diversity in Teknaf Nature Park (TNP) between July 2011 and October 2011. Visual encounter in addition to canopy sampling were used for the survey. A total of 24 species of frogs and toads in 6 families were recorded from this Park which was about 49 % of the total amphibian population of Bangladesh. Among these species 11 were rare, 6 were common and 7 were very common. Family Dicroglossidae comprised about 25% (6 species), Rhacophoridae 29% (7 species), Ranidae 21% (5 species) and Microhylide 17% (4 species) while family Bufonidae and Megophoridae has only 1 species (4%) each. Though Teknaf Nature Park supports a good number of amphibian species but destruction and alteration of their habitats and breeding grounds pose a great threat for their survival. Some local people of this area hunt bull frog and consume tadpoles of some frogs. Poached frogs are also found to sell in local markets. Consumption and trading of frogs is another major threat for the amphibians in this Nature Park.

Habitat selection of common Skipper Frog (*Euphlyctis cyanophlyctis*) in Chittagong University campus, Chittagong

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Abstract
A six month study was conducted from January to April and August to September 2014, for the parametric analysis of habitat selection of *Euphlyctis cyanophlyctis* in three water bodies of Chittagong University Campus (CUC), Chittagong. Understanding of parametric influences on a species is the baseline research of its conservation. The study was about to understand the influence of nine independent factors, viz., Air Temperature, Water Temperature, Dissolve Oxygen, Free Carbon Dioxide, Depth, Zooplankton Species Richness and Density, Size, Plant Species Richness on the habitat selection of the *Euphlyctis cyanophlyctis* and its density (the dependent variable).The fluctuations of the population of the skipper frog are highly (R^2 = 0.732, $p<0.001$) influenced by the combination of these nine independent variables. The combination of six abiotic factors have shown higher (68.3%, $p<0.001$) influence than the three biotic factors (30.1%, $p<0.001$). On the other hand the combination of static variables (does not change with time) is better influential than that of dynamic. Air temperature is found to be the highest influential on the temporal and spatial fluctuations of population of this frog, although the influences of factors in different sites work in different fashion.

Diversity and genetic erosion of citrus species at Jaintapur Upazila in Sylhet

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Abstract
Citrus (*Citrus species*) belongs to the family *Rutaceae*. The exact centre of origin is unknown, however, generally believed that all commercially important species were originated in southeast Asia (Whiteside *et al.* 1988; Davis and Albrigo, 1994) where there is greater diversity than anywhere in the world (McPhee, 1967). A study was undertaken to know the species diversity, relative prevalence and extent and causes of genetic erosion of citrus species at Jaintapur upazila of Sylhet district during July-November 2013. The information was collected from six unions through individual questionnaire. Fifteen citrus species were recorded from the studied homestead areas. Species density varied from

0.9-4.0 per homestead whilst it was 0.06-0.16 per 100 m2 homestead areas. The most prevalent species was Zara lebu (*Citrus medica*) followed by Ada jamir (*Citrus assamensis*), Komola lebu (*Citrus sinensis*), Kagzi lebu (*Citrus aurantifollia*), Batabi lebu, Deshi lebu (*Citrus limon*), Kurun jamir (*Citrus aurantium*) and Elachi lebu (*Citrus limon*). The highest species was identified in Charikata Union followed by Fatehpur, Chicknagul, Jaintapur and Darbast whereas it was the lowest in Nijpat. Sorbati lebu (*Citrus limmetta*) and Deshi lebu were identified as endangered while Kolombo lebu (*Citrus sp.* Lime group) and Pati lebu (*Citrus limon*) as critically endangered species, Kot lebu, Sulang lebu (*probably hybrid*) and Tuna lebu are extinct from the study area. On the other hand, Zara lebu, Ada jamir, Kata jamir (*Citrus jambhiri*), Kurun jamir, Elachi lebu, Kagzi lebu, Komola lebu were found in safe condition as they are still being grown commonly in most homesteads. Diseases and pest infestation were the most serious problems responsible for the genetic erosion of citrus species followed by lack of credit facilities and quality propagules of citrus species.

Assessing the impacts of mechanized vessel traffic on two species of freshwater dolphins and their habitats in the Sundarbans, Bangladesh

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Abstract
A mechanized vessel traffic route was established in 2011 through the eastern Sundarbans Reserved Forest where three wildlife sanctuaries for mainly two species of freshwater dolphins: Ganges River Dolphin (*Platanista gangetica gangetica*) and Irrawaddy Dolphin (*Orcaella brevirostris*) The wildlife sanctuaries in Dhangmari, Chandpai and Dudhmukhi cover in total of 19.4 kilometers aquatic areas in the Sundarbans. These wildlife sanctuaries are established for protecting in Bangledesh. The study was conducted to assess the impacts of the mechanized vessels on freshwater dolphins and their habitats. A land-based survey was conducted in two Wildlife Sanctuaries: Dhangmari and Chandpai for 28 days during November 2012 to February 2013. During the study period, on average 110-150 of both small and large mechanized vessels were seen running through the sanctuary areas everyday with an average speed of 8.2 km/h (range = 3-33, SD = 3.2). The mechanized vessels directly impact on the surfacing of dolphins. A total of 1,745 sightings of dolphins surfacing were recorded in Dhangmari WS and 1,254 in Chandpai WS. The frequencies of surfacing dolphin individuals were higher 57.84 per hour in Dhangmari WS and 15.6 per hour in Chandpai WS during low vessel traffic (10-24 per hour). The wave created by mechanized vessels is also responsible for the bank erosion of the Passur River. Approximately 70,000 square meters and 16,500 square meters of forest lands have been eroded in Dhangmari WS and Chandpai WS respectively. The eroded land area was estimated by comparing the shoreline data of 2008 and 2012. Some recommendations have been come out in order to sustain two species of freshwater dolphins and their habitats including the existing vessel traffic route must be stopped, national and international ships should be run at minimum speed, continuous dredging to avoid sedimentation and strict enforcement of laws and regulations.

Some aspects of breeding ecology of birds in Ramna Park, Dhaka

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Abstract
Birds are an important component of biodiversity that help to maintain ecological balance..A study was conducted at Ramna Park, Dhaka to collect primary data on some breeding bird species and to study some aspects of their breeding ecology. Data was collected from July, 2013 to June, 2014 on breeding seasonality, nest types, nesting trees, heights, materials used and particular nesting sites. A total of 17 species of birds were recorded to breed in the area during the study period. All these species belong to five orders and 10 families. House Crow (Scientific name), Asian Pied Starling (Scientific name), Common Myna (Scientific name) and House Sparrow (Scientific name) were the most dominated breeding species in the study area. During summer, the highest number of bird species (n = 10) performed their breeding activities. Five different nesting types namely, cup nest, pendant nest, platform nest, hole nest and dome nest were found. Birds under the order Falconiformes built their nests on the highest height of the trees (mean 22m). Highest number of nests was counted for the House Crow (n=245). Preferred tree species for nesting sites were higher towards the indigenous species. The main threats for the breeding species were, among others, cultural and social gatherings,

sound pollution and a great number of exotic plants. Ramna Park still contains some avifaunal diversity amid different anthropogenic threats. The study has the potentiality to determine the sustainability of birds in near future within urban areas and can help to conserve them in urban greeneries.

Captive rearing of a butterfly *Acraia violae* (tawny coster) in Jahangirnagar University Campus

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Abstract
The study was carried out on captive rearing of butterfly *Acraia violae* (Tawny Coster) under the family Acraeidae from February, 2013 to June, 2013 at Jahangirnagar University, Savar, Dhaka using larval host plant *Passiflora foetida* (Jhomkolata) . Rate of egg hatchability, pupal formation and eclosion of *A.violae* has been studied. Average duration of egg, larval, pupal and adult stages lasted for 2.4±0.48, 14±0.63, 4.4±0.48, 8.2±0.74 days respectively. *A. violae* took on average 20.8 days from egg to become adult. The average oviposition, egg hatchability, larval-pupal transformation and eclosion rate was 49.4±7.17, 29.2±7.35, 23.6±7.49, and 18.8±6.04 respectively. Rate of adult emergence was 37.012%. This study on captive rearing will be helpful for the conservation of threatened butterflies.

Status of the roosting population of Indian Flying Fox *Pteropus giganteus* (Brunnich, 1782) in Ramna Park, Dhaka

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Abstract
Bats are warm-blooded and true flying mammals with long life span, intelligence and complex social life. The Indian flying fox *Pteropus giganteus* is the largest of the bats and the most common and widely distributed species in Bangladesh. A study was conducted to assess the roosting populations of the species in Ramna Park, Dhaka from July 2013 to June 2014. Observation involved the direct roost count method three times a month to estimate the population size of the colony. The average roosting population size was 813 individuals. The highest 1254 and lowest 585 number of flying foxes were recorded on September and December respectively. The bats used 39 individuals of trees under seven different species namely, *Eucalyptus globules, Albizia lebbeck,Terminalia catappa, Enterolobium saman, Tectona grandis, Delonix regia* and *Neolamarckia cadamba*. No relationship was found between the temperature and number of roosting trees (T: TN=-0.00437) and poor relationship was found in the humidity and number of individuals (H: I=0.499775). Positive relationships were found between humidity and number of roosting trees (H: TN=0.664441), temperature and number of individuals (T:I=0.61044) and definitely between number of roosting trees and number of individuals (TN:I=0.74604). The threats for the bat colony were both anthropogenic and natural, mainly air and noise pollution, and habitat loss. Natural threats included disturbances by birds and storm. The study will help the future researcher with the status of flying foxes at a city park in Bangladesh and will provide an excellent example of how this species cope in a human dominated landscape.

Changes in the Avifauna of a Forest

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Abstract
Lawachara National Park, in Moulvi Bazar District, north-east Bangladesh covers 1,250 ha with a larger forest area - West Bhanugach Reserved Forest - with 1,390 ha of contiguous forest land. About a third of the park comprises of semi-evergreen tropical forest - old plantations from the 1920s and 1930s that retain a high diversity of native forest trees mixed with small patches of original forest, the remainder teak- mixed plantations from the 1960s and Albizia plantations from the 1980s. It is probably one of the best known forests in Bangladesh in terms of biodiversity.

Between 1986 and 2014 the author bird watched here on 133 days. Variable visit lengths were converted into full day equivalents (a full morning as 66% of a day reflecting easier detection, a half morning as 33% of a day, and short visits as 16% of a day). This gave 73 full day equivalents of observation spread over six five-year periods, 71% of effort was in the dry season and 29% in the wet season.

Out of 258 species of bird observed within Lawachara 193 were seen during this study. For species with eight or more dates of records trends were assessed: 46 appeared stable, 16 fluctuated, 21 increased and 25 decreased. Despite declaring the forest a protected area in 1996, and establishing co-management in 2004, species such as Pompadour Green Pigeon *Treron pompadora* and Asian Fairy Bluebird *Irena puella* (frugivores); and Black-headed Bulbul *Pycnonotus atriceps* and Ashy Bulbul *Hemixos flavala* (omnivores) declined. But four once common undergrowth insectivores have disappeared: Buff-breasted Babbler *Trichastoma tickelli*, Rufous-capped Babbler *Stachyridopsis ruficeps* and Grey-throated Babbler *Stachyris nigriceps* and Nepal Fulvetta *Alcippe nipalensis*. Clearance of undergrowth had a cumulated legacy from which species with low dispersal ability have been unable to recover.

Performing monkey population in Bangladesh

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Abstract
Monkey performance is a centuries' old tradition in Bangladesh. Monkey performers catch monkey, train and rear them for street show or any other gatherings to earn their livelihood. The study was conducted on performing monkey population in Bangladesh between January 2012 and June 2013. Monkey species, age-sex and other demographic features were recorded by visual observation. Monkey owners were consulted to estimate the total performing monkey populations in Bangladesh. Three species of monkeys, Rhesus Macaque (*Macaca mulatta*), Assamese Macaque (*Macaca assamensis*) and Pig-tailed Macaque (*Macaca leonina*) were found to use for performance. Rhesus macaque was the mostly used species (88%) followed by Pig-tailed Macaque (9%) and Assamese Macaque (3%). Monkey performers mostly prefer to use adult individuals (70%) for performance as they look attractive. Usually juveniles and infants were not used for the performance but monkey performers usually carry them with adult individuals for training purposes. Approximately 5000 individuals of monkeys was estimated to engage with business which is the largest captive stock of monkeys in Bangladesh. As the Wildlife (Conservation and Security) Act, 2012 does not allow keeping any monkey individual in captivity; a separate management plan is required to conserve this captive population as well as our centuries' old tradition of monkey performance.

Butterfly diversity and distributions in Lawachara National Park (LNP), Bangladesh

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Abstract

Butterfly is considered as a major bio-indicator species and plays some vital roles in regulating ecological processes. This study was aimed to estimate butterfly diversity across different habitats, and to quantify environmental influences on butterfly density distribution and habitat discrimination in Lawachara National Park. Species and environmental (i.e. temperature, humidity, disturbance intensity, altitude, canopy closure) data were collected from three distinct habitat types: forest road, railway and canal. Each habitat comprised 20 transects being 30m in length. The unified diversity index was used to measure diversity. Habitat classification test and butterfly distribution along environmental gradient was visualized and quantified using discriminant and canonical correspondence (CCA) analyses. Total 55 butterfly species belonging to 8 families and 44 genera were recorded. The result of unified diversity index showed a distinctive variation in the distribution of rare and common butterflies in three habitats. Among them, forest road sheltered more diverse species than other two habitats, considering both rare and common butterflies. Multivariate analysis revealed a strong effect of environmental variables (value of r with the Axis 1 being -0.728, -0.931 and -0.939 for temperature, humidity and disturbance intensity respectively) in butterfly species distribution for respective habitats. Also certain variables (disturbance, humidity) were found affecting the surroundings of forest canal and thus affecting butterfly distribution of the site. Some species were found effectively related to temperature and thus distributed accordingly. This study suggests consideration of more influential environmental variables for better understanding and recommends temporal quantification with frequent monitoring. The methodology adopted in this study can be used for butterfly diversity monitoring and also for distinguishing environmental stressor in the other hill forests in Bangladesh.

Potential impacts of *El-Nino* Southern Oscillation and meteorological disturbances on Artisanal fisheries of Bay of Bengal

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Abstract

El Nino Southern oscillation (ENSO) is important in Bay of Bengal. The study was conducted on 10 years from 2001 to 2011 fish catch (Artisanal) data of 12 fish landing stations of Chittagong coast of Bangladesh. There is a positive interaction between fishing effort and meteorological disturbances with the changing pattern of dipole monthly index and nino-3.4 index in the BOB during 2001-2011. Nino-3.4 index shows an irregular oscillation of 2-5 years during last 10 years. DMI was positively correlated with Nino-3.4 index. Very limited fishing effort was found during *El-nino* (warm phase) year of Bay of Bengal. From 2001 to 2005 Nino-3.4 value was positive and total fish catch were below 1000 metric ton with some fluctuation and during *La-nina* period total catch were near 5000 metric ton. Meteorological disturbance is one of a major concern to impact on total fish and shrimp catch in the northern part of Bay of Bengal. During 2007 signal frequency was strong when index value was positive. Major six cyclone frequency has passed over coastal area of Bangladesh during last 25 years on the basis of Bangladesh Meteorological Department record. Catch data of artisanal fish and shrimp is highly increasing with the significant increase of fishing trawlers but catch per trawler (CPU) is decreasing day by day. This study demonstrates the potential of using ENSO-based predictors for a seasonal hydro-climatic prediction scheme in coastal areas of Bangladesh. It shows the significant contrasts to the index value and other variables. These variables have been studied and correlated with fish catch in the northern part of Bay of Bengal over the same time period.

Diversity of finfish and shellfish of the river Halda with notes on their conservation

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Abstract
Biodiversity of fin-fish and shell-fish species in three sections of Halda River were investigated for two years from January 2007 to December 2008. Proportion of average daily catch (in number) was used to obtain the diversity indices. Simpson index of diversity (D) (0.54-0.66), Shannon index (H) (0.25-0.32) (re- scaled) and Evenness (E) (0.27-0.35) were calculated for fin fishes and shell fishes covering 39 km of the river. A total of 1017 catch samples of 34 different types of gear were analysed. Species richness (S) was observed to be 92 (83 fin-fish, 9 prawn), belonging to 14 orders, 37 families, and 71 genera including 3 exotic species over the studied area. Maximum number of species were recorded under the family Cyprinidae (19 species) followed by the family Gobiidae (11 species). Fin-fish species richness (FSR) in this study was 83, which was higher than earlier records (65). The actual total fin-fish and shell- fish species richness including the previous records was found to be 120 (106 fin-fish, 14 prawn), which is much higher than some larger river systems of Asia. Species richness was higher downstream (71 and 83 species) then mid (67 and 72 species) and upstream (61 and 69 species) for the years 2007 and 2008 respectively. No significant differences between the populations of two years ($F = 0.0025$, where df = 1/47, $P>0.05$) and among the populations of three sections ($F = 0.0008$, where df = 2/47, $P>0.05$) were noted. Three critically-endangered, nine endangered and eight vulnerable fish species (as in IUCN 2000) were observed in the population. Strong dominance of *Corica soborna* (55.1 %) followed by *Macrobrachium rosenbergii* (19.2%), *Setipinna phasa* (11.8 %), *Glossogobius giuris* (6.9 %) and *Macrobrachium villosimanus* (2.0 %) were observed. Three exotic species (ADD NAMES) were observed, which comprised of less than 0.001 % of the population. Suggestions are provided for protection, conservation and sustainable yield of the fish population of Halda River.

Population dynamics of gangetic hairfin anchovy Setipinna phasa (Hamilton) from Halda river, Bangladesh

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Abstract
Clupeid fish *Gangetic hairfin* anchovy *Setipinna phasa* is abundant in the lower part of the tidal Halda river. The fish is also commercially harvested from different rivers and also from the four linked rivers of Halda (Karnaphuli, Sangu, Chandkhali and Shikalbaha) Due to high demand in the market, fishing pressure on this species is a evident in different rivers. *S. phasa* contributes 5.3% to 6.4% of the total fishery of the River Halda. Due to over fishing and other man-made causes different open water fish species are now under threat and depleting. For sustainable yield and adopting management policies population study is essential. As earlier no such study was undertaken on the fish at the River Halda .For this study length frequency data of 285,366 specimens of *S. phasa* between 1-33 cm length were taken on monthly basis from January 2007 to December 2008. FiSAT II software was used to analyze the length frequency data. Through ELEFAN I routine of FiSAT II the asymptotic or ultimate length (L) and growth coefficient (K) of VBGF parameters were found to be 34.43 cm and 1.0 yr-1 respectively while by Powell-Wetherall plot module L and Z/K were estimated as 34.70 cm and 2.497 respectively and the predicted extreme length was estimated at 36.74 cm by maximum length estimation module. The natural mortality estimated by Pauly's equation was 1.690. The growth performance index (=3.047) indicated the better growth of the fish in the River Halda. The exploitation rates in different stages indicated that the fish was over exploited and was higher than maximum yield-per-recruit (Emax = 0.39). The fish recruited in the fishery twice a year, the first pulse in February produced 28.10% of the recruits while the other pulse in June produced 38.26%. Emphasis should be given on proper and requisite recruitment to overcome the over fishing and to generate maximum yield per-recruit.

Aquatic biodiversity of Shuthi-Shaiduli river in Bangladesh

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Abstract
Shuti-Shaiduli River harbored a rich diversity of fish, crab, snails and reptiles. The river basin works as natural reservoir. The experimental river comprises an average area of 21-23 km long course with an average depth of 2.83±0.02 m Survey of the experimental river and its flood plains was conducted during 2010 to 2013. The water of the river loss by various means caused shrinkage of the effective water area and lowering of depth in the river. Generally fishers' used seine net or bar jal, komor jal, thela jal, bua jal, lift net, cast net, current jal and various type fish traps, hook and lines; and fishing by dewatering FAD (Fish Aggregating Device) according to season and availability of different species of fishes. The percentage of catch statistics by using illegal current jal, bar jal (kaperi jal) and FAD were 23.80%, 29.40% and 35.10%; 17.60%, 21.70% and 26.40%; 9.90%, 10.10% and 11.00% in the year 2011, 2012 and 2013, respectively and using of current jal, bar jal (kaperi jal) and FAD differed significantly ($P<0.05$).species (89 fishes, 4 prawns, 1 crab, 2 snail and 2 reptiles) were identified from the river and its flood plains during the study period. The total production of the experimental river was decreased dramatically from 139.32±6.77 to 117.37±4.88 mt within four (2010-2012) years. But the total production of the river was slightly increased 118.95±4.88 mt in 2013 due to formation of community management group and enforcement of Fish Regulation Act-1950. As a result, commercial important 04 aquatic lives olive barb (*Puntius sarana*), gazar (*Channa marulius*), *Gachua Channa gachua* and reptiles (*Lissemys punctata*) were extinct, 22 commercial importance aquatic species was facing as extremely higher risk of extinction (Critically endangered, CR) and 24 species were endangered (EN), 30 aquatic wild species of the river was Vulnerable status (VL), 10 species of river was identified as Lower Risk (LR) and only 08 species of the river was Not threatened (NO) position between 2010 and 2013 in the river .For better management to save the stock of aquatic species in the river, a local management committee should be formed who developed a working frame-work.

Induced breeding of freshwater Goby, *Glossogobius giuris* (Hamilton, 1822) in the captivity: a preliminary study

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Abstract
Glossogobius giuris (Freshwater goby) is highly demanded and expensive fish with widely distributed and captured species in Bangladesh. The species is not yet reported to culture though only obtained in capture fisheries. Present study was the first trial to induce propagation of *G. giuris* in the captivity using different hormones. There were four treatments conducted such as (T_1) natural breeding in aquarium without hormones, (T_2) induced breeding using Ovaprim, (T_3) using HCG and (T_4) using PG. Each treatment had two replications. In each aquarium, 4 pairs of broods (sex ratio 1:1) were stocked. The ovaprim, HCG and PG double dose were injected for female and single dose for male in intramuscular. The water parameters such as pH, temperature and DO measured daily which recorded as 7.49-8.66, 27.00-30.930C and 3.80-4.47 mg L^{-1} respectively. Among the four treatments, highest spawn success (75% pairs) showed in treatment T_4 followed to T_3 and T_1. Spawning occurred within 48 h of injection of 2nd dose and the spawning duration recorded up to 30 min. The eggs were started to hatch within 36 h of spawning which completed (highest 80%) within 72 h. The fecundity of the species recorded 8050-10070. The results showed that induce breeding of *G. giurisis* possible either with HCG or PG hormones. However, further studies are suggested to confirm the findings as well as optimization of the hormone doses.

Breeding ecology and development of Indo pacific mangrove crab (*Perisesarma bidens*) by Artificial Insemination

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Abstract
The artificial insemination and early embryonic development of mangrove crab as well as most other crabs are completely lacking to date. The embryology of brachyuran crabs was examined haphazardly throughout the world, but no standard exists for defining the developmental stages. The aim of the study was to explore a technique of artificial insemination and document the early embryonic development of the Indo-pacific mangrove sesarmid crab *Perisesarma bidens* (De Haan). The female extruded the eggs into the abdominal cavity within 24-48 hours after copulation. The unfertilized eggs were collected from the pleopods of the female immediately after laying and were stored in 80% filtered sea water (FSW). Sperm were removed from the spermatheca of the same female and diluted in 80% FSW. The unfertilized eggs and sperm were shaken well in a glass beaker for artificial insemination. The eggs were rinsed 3-5 times with 80% FSW after 5 minutes of mixing of sperm with ova. Eggs were incubated in 100ml flat cylindrical culture bottles containing 70ml of 80% FSW at 25°C in a water bath. The fertilization membrane was observed 3-5 minutes after insemination. An average of 65% of fertilized eggs hatched as first zoeae after 17 days of incubation. This was the first on successful artificial insemination of the Red Clawed Crab (*P. bidens*). Results strongly suggest that the fertilization of *P. bidens* is of the moderately internal type that occurs in the abdominal cavity. Females store sperm in the spermatheca, and their release was induced by internal stimuli after egg extrusion into the pleopods of the female. Thus the findings of the study add a new avenue for managing mangrove ecosystems and biodiversity conservation using artificial insemination. The technique is simple and can be used during the peak breeding season for large-scale larval production at minimal costs. However, more research is necessary to explore the induction of mating so that gametes can easily be collected for artificial insemination in order to facilitate large scale seed production for crab farming. This finding inspired us to study artificial insemination and early embryonic development of *P. bidens* which is of great importance to crab fisheries for artificial seed production, the biological balance in mangrove ecosystems, and the conservation of species diversity and its management mangroves.

Present status and potential extinction risks of fishes of Northwest Bangladesh

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Abstract
The Dinajpur district of northwest Bangladesh is traversed by several rivers which provide suitable habitat for a good number of freshwater fishes and support the livelihoods of fishermen in the area. The fish of present in three major rivers, the Dhepa, the Punarbahaba and the Atrai, were investigated over the period July 2010 to June 2013 using monthly sampling at 9 reference sites. A total of 6653 fish samples from the sites were collected and identified as 84 species from 21 families. Of these 72 species were indigenous and 12 were exotic to Bangladesh, where 44 indigenous fishes are in different categories of IUCN red list (2000). Among these fishes 7 belongs to critically endangered categroy, 17 are in endangered category, 9 are in vulnerable category and rest 11 belongs to data deficient category. One hundred eighty fishermen were interviewed concerning their views of threats to the riverine fish of Dinajpur. Fishermen observed problems of massive siltation of river beds leading to low water flows in the dry season and floods in the rainy seasons. During the dry season the low water volume facilitates the indiscriminate fishing of fishermen in these rivers. The accidental introduction of exotic fishes to the rivers due to flooding of perrenial culture ponds destroying the riverine ecosystem for native species. The sudden siltation flush water from the upstream river basin beyond the border of the country is a transboundary issue. Thus international mitigation measures need be taken to protect the riverine fishes of Bangladesh from the upcoming challenges of ecological changes.

Invasion of Nile Tilapia, *Oreochromis niloticus* (Linnaeus, 1758) in Kaptai Lake, Bangladesh

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Abstract
Nile tilapia (*Oreochromis niloticus*) fishery in the Kaptai Lake of Rangamati district, Bangladesh was aimed to determine the existing status ,invasion and present condition of fishery, fishers, fishing gears, catch records and management policies for the Lake. Relevant information and pertinent to data were collected by personal observation and other participatory methods. It is revealed that tilapia was introduced in this Lake in 1986 and it was found that in 2000 and 2001, tilapia harvesting were in peak that provided 1.6 lac Kg (2.94%) and 1.8 lac Kg (3.51%). But in 2009, the production was 31,850 Kg which contributed 0.86% of the total fish production in the Kaptai Lake. Professional fishermen, seasonal professional fishermen and subsistence fishermen are engaged in tilapia fishing during the fishing season (September-April). A total of six types of nets, one type of wounding gear, four types of hook & line and one type of fish aggregating device were found to use in tilapia fishing. Among the different types of nets, the highest number of tilapia catch was recorded in lift net (32%), and the lowest in cast net (3%). It was also found that the lake fishing was totally closed during the spawning season (May-August). But it was regulated only for the protection of major carps. For being an exotic fish species, tilapia is being neglected by the management authority and no management techniques and regulations were established for protection. Recommendations were made to improve the tilapia production through good management practice, established nursery and breeding grounds, ban of illegal fishing during spawning season as well as active community participation for sustainable catch. In conclusion it is recommended that government should take important steps for the management practices of tilapia in the form of input and output controls.

Forty years of fish conservation in Bangladesh: Losing its diversity to date

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Abstract
Bangladeshis' love of fish is reflected in the national saying Machh-e- Bhat-e-Bangali (fish and rice make a Bengali), but this love comes at a cost. The country's indigenous fish species are catastrophically threatened due to increased and indiscriminate fishing practices, large scale water abstraction, construction of barrages and dams, over exploitation of stocks, unregulated introduction of alien fish and pollution from industry. As a consequence, many Bangladeshi fish species are either critically endangered or extinct. Since 2000, Fish Museum & Biodiversity Center (FMBC), Bangladesh Agricultural University (BAU), has been conducting survey with the objective to evaluate biodiversity status of riverine fishes, fundamental causes of biodiversity loss and conservation measures by direct visit to fish habitats, landing center, markets all over the country. Red List (IUCN-Bangladesh, 2000), placed 54 indigenous fishes under threatened category. However, there have been massive changes in riverine fish biodiversity over the last decade. According to survey conducted by FMBC, more than 100 riverine fishes are presently under severe threat with some already lost. The survey also found fish species never been recorded before in Bangladesh (like croaking gourami, *Trichopsis vittata* was found from the Meghna, Munshigonj and adjacent floodplain, previously reported only from Cambodia, Thailand and Vietnam). We also identified 25 fish species – probably extinct from Bangladesh waters. We found several new fish, yet to be described/named along with very rare species like copper mahaseer, riverine pipefishes, stone catfishes, torrent catfishes, mottled eel and many more. Among ongoing conservation measures, fish sanctuaries are proved to be most important and efficient tool in protection and conservation of fishes and other aquatic organisms and helped in reviving many rare species. There is a crying need to adjust existing laws and legislation to save fisheries resources. Although much of damage to fish habitat and biodiversity likely to be irreversible, there is still time to act. A renewable resource like fish, when under intense exploitation, needs a management regime that ensures young fish are protected to grow before capture and enough are left as breeding stock for future generations by regulating fishing intensity at sustainable level,

control gear type and fish size, closed season and fish sanctuary. We believe that outcomes of FMBC survey will provoke thought of people of all strata –fishers, fish farmers, consumers, researchers, donors, policy makers and others, and will encourage them to come forward to find effective ways to preserve fish biodiversity - the pride, heritage and livelihood of Bangladesh - before they are lost forever.

Resolution of confusion in systematics of two major clupeid fish species in Bangladesh

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Abstract
Hilsa shad, *Tenualosa ilisha* (Hamilton and Buchanan, 1822) and Indian River shad, *Gudusia chapra* (Hamilton and Buchanan, 1822) are two major clupeid fish species in Bangladesh. In spite of having enormous significance of *T. ilisha* and *G. chapra* in fisheries sector, these two clupeid fish species are under serious human exploitation for food, nutrition and income. The original concept and the principal impetus under the current study is that pre-juvenile hilsa shad (jatka) resemble Indian River shad (chapila) externally and this usually leads to social chaos which creates huge confusion and conflict. So to overcome this confusion, systematics study (morphometric measurements, meristic counts and external morphology) of hilsa shad and Indian river shad was conducted. Significant differences were found between the systematics of hilsa shad and Indian River shad at one hand in the present study, and on the other, pre-juvenile hilsa shad (jatka) and Indian River shad were externally distinctly different. Pre-juvenile hilsa shad (jatka) differed morph metrically from Indian river shad by having the ratios of ED: SL= 0.09 vs. 0.11, BD: SL= 0.32 vs. 0.33, HD: SL= 0.27 vs. 0.32, HL: SL=0.31 vs. 0.34, PvFL: SL= 0.50 vs. 0.52, ML: SL=0.14 vs. 0.16, and MW: SL= 0.04 vs. 0.06. Pre-juvenile hilsa shad (jatka) also differed meristically from Indian river shad by having dorsal fin rays (18 to 19 vs. 14 to 16), pectoral fin rays (15 to 16 vs. 12 to 14), anal fin rays (20 to 24 vs. 22 to 24), caudal fin rays (22 to 26 vs. 18 to 20), total number of scutes (30 to 31 vs. 28 to 29), pre-pelvic scutes (16 to 17 vs. 18 to 19), post-pelvic scutes (14 to 15 vs. 9 to 10), and vertebral segments (48 to 49 vs. 41 to 43). It was also found that pre-juvenile hilsa shad (jatka) differed externally from Indian river shad by having thicker body, big and upturned mouth, unequal jaws, homocercal caudal fin and a number of small black spots (5-7) along the flank behind gill opening. If these conflicts are solved then the fishers will be unable to keep people in fix by introducing jatka as chapila and the law enforcement authorities will be able to perform their duties properly without any confusion. By establishing the comparison key and making aware the fact of significant differences between pre-juvenile hilsa shad (jatka) and Indian river shad, it will be possible to stop fishers from catching and selling of pre-juvenile hilsa shad (jatka). Through this the pre-juvenile hilsa shad (jatka) will be able to grow in, which ultimately sustain the total hilsa production in our country. Finally, the whole nation will be benefited nutritionally as well as economically through sustaining hilsa population in Bangladesh waters.

Captive breeding of striped spiny eel, *Mastacembelus pancalus* (Hamilton, 1822) considering the various hormonal responses

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Abstract
This experiment was conducted at the laboratory of Fisheries & Marine Bioscience Department in Jessore University of Science & Technology to investigate the effects of using different hormones on the spawning performance of Spiny eel, *Mastacembelus pancalus*. There were three treatments conducted to induce the species such as (T1) induce using synthetic hormone ovaprim, (T2) induce using human chorionic gonadotropin (HCG) and (T3) induce using carp pituitary extract (PG). Each treatment had one more replication. Brood fishes were collected from the local baor. Hormones were

administered in two doses; a lower priming dose followed a 6 hours interval by a higher resolving dose. In first dose ovaprim, HCG and PG were used in female at 0.5 ml/kg, 400 IU/kg and 60 mg/kg of body weight respectively. The second dose was applied to both male and female and female received double amount of hormone of the first dose. The male received 0.1 ml/kg, 4 IU/kg and 0.3 mg/kg of ovaprim, HCG and PG respectively. The water parameters such as pH, temperature and DO measured daily which recorded as 7.5-8.69, 27.00-30.000C and 4.00-4.90 mg L-1 respectively. Among the three treatments, though the highest spawn success (100% pairs) showed in both treatments T1 and T2, the highest hatching (55%) showed in T1. Spawning occurred within 35 h of injection of 2nd dose. The eggs were started to hatch within 32 h of spawning which completed within 72 h. The fecundity of the species recorded 1960-2286.This experiment indicated that the use of ovaprim is more effective in ovulation, fertilization and hatching compared to the other spawning stimulators.

Breeding ecology and development of Indo Pacific mangrove crab (*Perisesarma bidens*) by Artificial Insemination

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Abstract
The artificial insemination and early embryonic development of mangrove crab as well as most other crabs are completely lacking to date. The embryology of brachyuran crabs was examined haphazardly throughout the world, but no standard exists for defining the developmental stages. The aim of the study was to explore a technique of artificial insemination and document the early embryonic development of the Indo-pacific mangrove sesarmid crab *Perisesarma bidens* (De Haan). The female extruded the eggs into the abdominal cavity within 24-48 hours after copulation. The unfertilized eggs were collected from the pleopods of the female immediately after laying and were stored in 80% filtered sea water (FSW). Sperm were removed from the spermatheca of the same female and diluted in 80% FSW. The unfertilized eggs and sperm were shaken well in a glass beaker for artificial insemination. The eggs were rinsed 3-5 times with 80% FSW after 5 minutes of mixing of sperm with ova. Eggs were incubated in 100ml flat cylindrical culture bottles containing 70ml of 80% FSW at 25°C in a water bath. The fertilization membrane was observed 3-5 minutes after insemination. An average of 65% of fertilized eggs hatched as first zoeae after 17 days of incubation. This was the first on successful artificial insemination of the Red Clawed Crab (*P. bidens*). Results strongly suggest that the fertilization of *P. bidens* is of the moderately internal type that occurs in the abdominal cavity. Females store sperm in the spermatheca, and their release was induced by internal stimuli after egg extrusion into the pleopods of the female. Thus the findings of the study add a new avenue for managing mangrove ecosystems and biodiversity conservation using artificial insemination. The technique is simple and can be used during the peak breeding season for large-scale larval production at minimal costs. However, more research is necessary to explore the induction of mating so that gametes can easily be collected for artificial insemination in order to facilitate large scale seed production for crab farming. This finding inspired us to study artificial insemination and early embryonic development of *P. bidens* which is of great importance to crab fisheries for artificial seed production, the biological balance in mangrove ecosystems, and the conservation of species diversity and its management mangroves.

Population dynamics of three indigenous species (*Mystus vittatus, Gudusia chapra* and *Parambassis ranga*) in the Mokosh Beel, Gazipur, Bangladesh

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Abstract
The von Bertalanffy growth model parameters (L∞ and K) and mortality coefficient (Z, M and F) were estimated for 3 indigenous species in the Mokosh beel, Gazipur, Bangladesh. The species taken into account were *Mystus vittatus*, *Gudusia chapra* and *Parambassis ranga*. Length frequency data were collected monthly from May to December, 2010. Powell-Wetherall method suggested an additional estimation of asymptotic length (L∞) and these were found to be 15.26,

20.0 and 10.5 cm for *M. vittatus*, *G.chapra* and *P. ranga* respectively. The Powell-Wetherall method also suggested the ratio of the co-efficient of mortality and growth (Z/K) and these were found to be 1.34, 1.33 and 2.77 for *M. vittatus, G. chapra* and *P. ranga* respectively. Peak recruitment occurred in July for these three species. The growth and exploitation parameters obtained were compared with available estimates to evaluate the consistency of the results with current knowledge about the species in the region. This study reveals that Mokosh beel fisheries not exceed optimum fishing pressure and the beel was well managed by the co-management organization in 2010.

Length–weight relationships of selected freshwater fishes form the Sunamganj District of Bangladesh

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Abstract
The paper presents the results of studies carried out on length-weight relationships (LWRs) of 5 freshwater fish species from the catches in the Shonir haor and Matianhaor in Sunamganj district during 2009-10. The objective was to evaluate the pattern of LWRs of the freshwater fish species which serves as baseline for Bangladesh haor beels. Present study was conducted to determine the relationship between total length and weight of *Nandus nandus* (n=2213), *Xenentodon cancila* (n=2493), *Gudusia chapra* (n=2095), *Heteropneustes fossilis* (n=2441) and *Macrognathus aculeatus* (n=2100) in the haor water .Total length of each fish were measured to the nearest 0.25 cm and individual weight was recorded to the nearest 1.0 g. Descriptive statistics and estimated parameters of the length-weight relationship for five species showed that the growth coefficient (b) values varied between 2.844 and 3.372, with mean b=3.0706 for the five fishes, and this indicates a nearly isometric relationship in body weight being accounted for by changes in length.

DNA Marker-assisted Selection in Nile Tilapia: A food security approach

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Abstract
Monosex (male) Nile tilapia *Oreochromis niloticus* is highly preferable for commercial production system to control unwanted reproduction by females and to obtain higher growth of even sized male tilapia. The technique of producing all male using androgen hormone is being widely used in Bangladesh. The aim of the current study was to observe if DNA markers could assist selection of YY males in tilapia for the production of genetically male offspring. The relevant experiments were conducted in the Field complex and Fish Genetics and Biotechnology laboratory of the Faculty of Fisheries, Bangladesh Agricultural University. Initially hormonal sex reversal of mixed sex had been performed. Estrogen hormone treatment was conducted to convert sex of XY males to 'XY females'. 300 fry were released in each aquarium. The hormonal treatment was conducted for a period of 1 month. The fry were reared upto sexual maturity. The male species were discarded after final screening at sexual maturity. The mixture of both XX and XY females were kept for further breeding trials and molecular analysis. A total of nine fish (Presumably XX or XY female) were bred successfully with XY males. Progeny sex ratios of nine families were observed. DNA marker analysis was performed for two of the families involving 45 fish in each family. Three neofemales had been identified and kept as future bloodstock for using as a source to provide putative YY stock. Marker analyses were carried out 15 microsatellite DNA markers. Two DNA markers namely ARO172 and UNH985 were found to be informative. The distinct pattern of allelic inheritance in different genotypes (XX, XY, and YY) of Nile tilapia inferred the suitability of DNA microsatellite markers for monosex production approach.

What Makes Gorai River Inhabitable for Migratory Fishes and Habitable at the Lower Madhumati River System?

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Abstract
The river Gorai is one of the major distributaries of the river Padma (=Ganges) that originating from the town of Kushtia supplies freshwater to the Sundarban mangrove forest through Madhumati and Baleswari river system. Over the last few decades the dry season ceased considerable amount of flowing water resulting number of environmental consequences. This study assessed the biodiversity and habitat quality visualizes serious environmental humiliation. The most apparent impact in the dry season is the low water flow followed by loss of biodiversity and fish catch in the Gorai river system. The river once was home for diverse groups of migratory fishes including the Hilsa. Due to the less water availability in the lean season, the abundance of Hilsa was found to be restricted to some limited period of the year after flood. The overall situation of Gorai river can be considered as 'dying river'. In this study we found that the perspective of this dying river is still associated with the tourism and sand mining. Contrary, Hilsa and other migratory fishes are available all seasons but in few numbers at the downstream Madhumati river. However the cease of migration route due to the siltation and low water depth throughout the Gorai river system could be the limiting factor for fish abundance in these rivers. From this study it was evident that ample water flow and higher depth are the prime need for the increase of natural fish production of the Gorai-Madhumati river system. We propose for the introduction of fish cage culture in the Madhumati river to enhance fish supply to the locality and develop fish based economy. In addition, sanctuary could be established in the Madhumati river for improving the aquatic biodiversity proliferation. We also propose for change in cropping patterns along the Gorai river bed to save the catchment water.

Biodiversity in the Chalan Beel, Northwestern Bangladesh

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Abstract
Chalan Beel plays an important for livelihood of rural people including fisher, fish traders, fish farmers etc. In addition, beels are important in terms of huge fisheries resources and other purposes of irrigation and domestic uses. Chalan Beel is one of the most important fisheries resources in the northwestern Bangladesh. This study looked upon the fish biodiversity and major threats to biodiversity to provide recommendations for conservation. Sampling was conducted on monthly basis during January to December 2013 from fishermen catch landed at different fish landing centers at Ruhul Beel a part of the Chalan Beel located at Bhangura Upazila under Pabna District. During the study 37 species of fish belonging to 8 order and 18 families were recorded. Cypriniformes was the most dominant order. Among the 37 species 7 were endangered, 27 were vulnerable and 3 were critically endangered after IUCN,B (2000). Major threats to fish biodiversity included habitat destruction, water pollution, indiscriminate harvesting of fish and draught. Restocking economically important fish species, establishing and maintaining fishery sanctuaries, banning overfishing and destructive fishing gears, strengthening community based organizations, identification and protection of the breeding and nursery grounds are recommended for the conservation of fish biodiversity in the Chalan Beel.

Neem (*Azadirachta indica*) Seed Oil as an alternative Treatment for eradicating Predatory Backswimmers (*Notonecta* sp.) in Fish Nursery Ponds

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Abstract

The objectives of this study was to determine the effects of neem seed oil as an alternative of pesticide to eradicate backswimmers from Stinging Catfish - shing (*Heteropneustes fossilis*) nursery ponds and to investigate the toxic effects of neem seed oil and Sumithion on shing larvae. The study was conducted at backyard hatchery of Fisheries Faculty, Bangladesh Agricultural University, Bangladesh during the late monsoon (August), 2013. Six concentrations (0.06ml/100L-N1, 0.125ml/100L-N2, 0.25ml/100L-N3, 0.5ml/100L-N4, 1.0ml/100L-N5, 2.0ml/100L-N6) of neem seed oil, one concentration (0.06ml/100L-S) of Sumithion and one control were kept in aquaria (30inch × 18 inch × 18 inch of each) to observe the effects on backswimmers. We put 100 individuals of backswimmers in each aquarium and observed the mortality as an endpoint. We assessed the LC50 for neem seed oil and Sumithion presticide on back swimmers were 58, 50, 43, 38, 35, 31, 155 and 1083 minutes for N1, N2, N3, N4, N5, N6, S and respectively. Developmental deformities of shing larvae using neem seed oil (0.06 ml/100L), Sumithion (0.06 ml/100L) and control were observed. Neem seed oil did not show any deformity in shing larvae but Sumithion showed deformities like notochord deformity, yolk-sac damage, tissue degradation and erratic movement. It could be concluded that the use of neem seed oil can be used as an alternative option for the eradication of backswimmers from fish larvae nursery pond. Using neem seed oil in a nursery pond has better environmental options for the shing larvae so that we can get more healthy larvae.

Mud Crab (*Scylla* sp.) Fishery in Bangladesh: Opportunities and problems in marketing

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Abstract

Among different species of crabs in Bangladesh waters, mud crab (*Scylla sp.*) is one of the exportable commercial species. After the outbreak of shrimp disease in 2010-2011, there is upsurge of interest in crab culture especially in the southern part of Bangladesh. Since 1977 Bangladesh started the exporting of mud crab. Sources of mud crab to the markets are: natural sources, traditional shrimp gher and the traditional fattening ponds. About 90% of exportable crabs come from these sources. Taiwan and Malaysia are two biggest buyers of mud crab from Bangladesh. Bangladesh fetched about 6280,000 US$ and 6286,000 US$ from Taiwan and Malaysia which together constituted more than 60% of the total export value earned from Asian countries during 1997-98 to 2006-07. However, sometimes fishing communities in Bangladesh use unselected fishing gear and heavily exploit the brood stock which ultimately decreasing the average size of mud crab. Moreover, the habitat destruction as well as declining quality of the coastal environment is also manipulating the situation to be worse. In addition, the illegal export of underweight crabs also persuade the over fishing of juvenile crabs from the natural source leading the species into an endangered state. Considering its prospects, mud crab fishery and farming can be new sources of income in the south western area of Bangladesh. Therefore, well developed co-operation and partnership among different stakeholder in this sector is needed for the conservation and for the sustainable development of this fishery.

Diversity of fishes of Bangshi River at Mirzapur upazila of Tangail district

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Abstract
Bangshi River originates in Jamalpur, from the course of the old Brahmaputra and flows past the Madhupur tract. The study was conducted from July, 2013 to March, 2014 at three site of Bangshi River. The fish samples were collected from the direct fish catch by the fishermen. Objectives of the study were to observe the diversity of the fish species, identify the status and abundance of the fishes, relative abundance in different seasons, and detect the possible causes of fish species declination. Present investigation reveals, a total of 53 fish species belonging to 37 genera, 21 families and 9 orders. Order Cypriniformes was recorded as the most diversified fish group in terms of both number of species and individuals observed besides Siluriformes, Perciformes, Clupeiformes, Channiformes, Mastacembeliformes. Order Osteoglossiformes, Tetraodontiformes, Beloniformes were also present in small quantity. Highest recorded species were belongs to Family Cyprinidae (31%). The monthly abundance for each sampling zone sharply reduced from November to January and gradually increased February to April. Fishes are more abundant in post monsoon period (47%), less abundant in dry season (28%) and monsoon period (25%). 14 species were found very rare in this river not threatened in Bangladesh. The fish diversity of Bangladesh is alarmingly declining day by day. It also hampers the inland fish production. Therefore, it is important to take necessary steps to protect the fish diversity and maintain their abundance in different water bodies. Implementation of fish acts and legislation is very important as over fishing is detected as the main cause of their declination. This study can be used as a primary data for any research in the adjacent areas.

Studies on the helminth parasites of two freshwater fishes, viz., *Channa punctatus* (Bloch, 1793) and *Anabas testudineus* (Bloch, 1795) of Chittagong area

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Abstract
Helminth parasites of two freshwater fish species, viz., *Channa punctatus* (Channidae, Channiformes) and *Anabas testudineus* (Anabantidae, Perciformes), were studied. The fish specimens were collected from different fish markets of Chittagong city. A total of 160 host specimens were autopsied during January 2009 to August 2009. Only 4 helminth species were found to infest those hosts. Of which 2 were trematodes (*Gonocercella minutus* and *Otiotrema sp.*),1 nematode (*Camallanus anabantis*) and 1 acanthocephalan (*Pallisentis nandai*). Detailed morphometric study of the parasites has been made. Of the 4, *C. anabantis* and *P. nandai* were common to both hosts, whereas *G. minutus* and *Otiotrema sp*. were restricted only to *C. punctatus*. The three epidemiological parameters – prevalence (%), abundance and intensity were studied. Higher prevalence of infection occurred during the winter and the mid rainy season in both the two host species. Parasite infection has been analyzed with respect to length and weight groups of the hosts. Only in the case of *G. minutus*, prevalence of infection appeared to increase with increase of length and weight of host, that too only in *C. punctatus*. In the cases of the other 3 parasite species, no definite pattern was observed in the relationship between prevalence of infection and length/weight of host. In the present work, intestine was the most favourite site of parasitic infestation. In both host species, prevalence of infection appeared to be higher in female hosts than that of males, though the result was not statistically significant.

Study on some aspects of the biology of Gangetic Whiting, *Sillaginopsis panijus* (Hamilton, 1822) from Chittagong, Bangladesh

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Abstract
Sillaginopsis panijus is a familiar fish species which is dynamic in the nature. This study brings the population parameters of S. panijus which were estimated based on the length-frequency data collected from the Bay of Bengal in Chittagong region of Bangladesh. The study carried out from January 2012 to December 2012. FiSAT software was used to analyze and estimate the parameters. The ultimate goal of this study is to evolve a sound management and conservation policy for the development of this fishery, based on the results obtained. The asymptotic length ( ) were estimated 30.98 cm (male) and 27.04 cm (female). Growth co-efficient (K) were estimated 0.46 y–1 and 0.45 y–1 for male and female respectively. The instantaneous total mortality coefficients (Z) were estimated at 2.19 y–1 (male) and 2.42 y–1 (female). The value of exploitation rate (E) was found 0.52 and 0.56 for male and female respectively which clearly pointed toward over fishing condition of *S. panijus* in Bay of Bengal. The sex ratio of male and female fish shows disproportionate occurrence in the number of two sexes of *S. panijus* (1.45:1.00). However, the *S. panijus* showed well marked sexual dimorphism and the gonads undergo marked cyclic morphological changes before reaching full maturity. Two spawning period were observed in *S. panijus* – during the winter (November to early April) and the monsoon (July to August). On the basis of morphological features five maturity stages were recognized for female and two for male. The present study reveals that the fecundity of *S. panijus* ranged 487,247 to 1,589,437 with a mean fecundity of 1032051±372544. Total length, body weight and gonad weight show linear and positive relationships with fecundity but ova diameter have negative relationship with it. From the fecundity study it may be concluded that this fish is a highly fecund fish.

Availability of fish species in the Rupsha river, Bangladesh: Threat identification and recommendation for sustainable management

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Abstract
The Ruphsa is one of the most important rivers from fisheries aspects in southwestern Bangladesh that plays an important role in supporting livelihood and nutritional security to the people living alongside through different fisheries activities. The present study was conducted to assess fish species availability in the Rupsha River during February 2011 to January 2012. A total of 64 species of fish under 11 orders and 30 families were documented during the study period. Perciformes was the most dominant order constituting 34.38% of the total fish population followed by the Cypriniformes (25%),Siluriformes (18.75%), Clupeiformes (4.69%), Synbranchiformes (4.69%), Mugiliformes (3.13%) and Tetraodontiformes (3.13%). Osteoglossiformes, Beloniformes, Anguiliformes and Aulopiformes were the least numerous orders constituting only 1.56% each of the total fish population. Among them, 5 species were vulnerable, 8 species were endangered and only one species was critically endangered. Furthermore, 48.43% of the available fishes are categorized as rare or very rare in the present study while whereas only 23.44% species were available in large quantities throughout the year. Major threats to the fisheries resources in the Rupsha River include destructive fishing methods applied by different fishermen, indiscriminate fishing of fry-fingerlings and gravid females, habitat modification, water diversion, siltation and low water velocity. Establishing fish sanctuaries, banning destructive indiscriminate fishing, identification and protection of the breeding and nursery grounds, encouraging the farmers to introduce integrated pest management

(IPM) techniques, introduction of fish bypasses to facilitate fish migration, training of the fishermen, encourage community based organizations for fisheries management at community level, establishment of waste treatment plants in the factories, and finally strict implementation of existing conservation regulations and ensuring proper punishment of the culprits are recommended for sustainable management and conservation of fisheries resources in the Rupsha River, Bangladesh.

Dwindling biodiversity in the Padma River: Habitat protection for fish species conservation

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Abstract
The Padma River is one of the major trans-boundary rivers of Bangladesh that is affluent in fish diversity and supports the livelihood of people living alongside. However, recent reports vigorously designate the declining biodiversity in this river; therefore, the present study was conducted to assess the fish biodiversity and to identify the main threats to biodiversity. Fish biodiversity was assessed through studying the fishermen's catch from the Padma River landed between Godagari (24°27'00"N 88°19'12"E) and Charghat (24°16'12"N 88°43'48"E), Rajshahi, northwestern Bangladesh during March 2009 to February 2010 and subsequently assessed the results during March 2010 to February 2012. Threats to fish species were identified through field survey, group discussion and interviewing of fishermen and fisheries cognate personnel through pre-prepared questionnaire. A total of 80 species of fish under 9 orders and 24 families were recorded. Cypriniformes was the most ascendant order constituting 35% of the fish population followed by Siluriformes (32.50%) and Perciformes (17.50%). The findings revealed fewer fish species than the antecedent studies. Alarmingly 42.53% of the species found during the study were threatened to extinction. Loss of natural habitat due to reduced water flow and modification of river through different embankment and development projects as well as indiscriminate fishing throughout the year were found as the major threats for fish biodiversity in the Padma River. Establishing and maintaining fishery sanctuaries, authorizing closed fishing seasons, ostracizing indiscriminate and destructive fishing, and maintenance of the breeding and nursery grounds are required for the conservation of fish biodiversity. Habitat restoration programs are crucial for rehabilitation of the fish species. Further studies on species specific life history traits are recommended for updating the existing fish protection and conservation of fish acts. Vigorous monitoring and stringent implementation of the acts are essential for the conservation of fish species in the Padma River.

High hatching success of saltwater crocodile (*Crocodylus porosus*) in a commercial crocodile farm of Bangladesh

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Abstract
An extensive study was conducted from March 2007 to February 2011 on hatching success of saltwater crocodile (*Crocodylus porosus*) in the Reptiles Farm Ltd. (RFL) located at Hatiber village of Uthura union under Bhaluka upazila in Mymensingh. The study was mainly based on direct field observation and some previous data collected by farm's technicians. A special type of incubator having 98-100% moisture and 31-330c temperature was maintained to improve the hatching success. Yearly hatching success in captivity was 95.8%, 95.15%, 97.44%, 96.03% and 94.53% in 2007 through 2011. The average rate of hatching success in RFL was 95.8 ± 1.09%. 100% hatching success was found in 29 out of 56 clutches. Clutch size varied from 19-68 eggs. Unhatched eggs were 4.19% of which most of the embryos died before hatching. The average time required for incubation was 79 ± 3, 79.5 ± 4.5, 80 ± 4, 80.5 ± 4.5 and 78.5 ± 3.5 days respectively in the above mentioned period. Compared to the wild habitat, captive environment in controlled weather and predation might improve hatching rates. This study suggests that conservation of this endangered species is possible by captive breeding and reintroduction program.

Inventory of fish species, fishing gear and crafts in the most polluted River- Buriganga in Bangladesh

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Abstract
An inventory of fishes were carried out in the River Buriganga, which is recognized as the most polluted river in Bangladesh. The study was carried out in stretches within the river, starting from Bangladesh-China Friendship Bridge (Postoghola bridge) (90°26´12" E and 23°40´25"N) to Amin Bazar Bridge (90°20´12"E and 23°46´25"N) fortnightly for a period of twelve months from December 2012 to November 2013. Fish species, fishing gears and crafts were observed and fish samples were collected directly from fishermen to confirm identification. A total of 56 species of freshwater fishes were identified and recorded with total length and weight under 9 orders and 20 families. Twelve different types of gears of two categories (active and passive gear) and 2 types of crafts were observed to be used for fishing in the study area. Order Cypriniformes dominated with 32% of the total fish species. Seasonal variations were also observed in fish species and gears. The highest number of species of fishes (n = 56) were recorded in August and the lowest (n = 3) in April and May, 2013. Three species named *Channa punctatus*, *Heteropneustes fossilis* and *Colisa fasciata* were found throughout the year while *Osteobrama cotio, Oreochromis mossambicus, Pseudambassis lalaonce* in August only. The maximum number of gears were observed to operate in October (78 gears) and the minimum in March and April (1gear). A total of 5 different types of boats of 2 categories (engine boat and non-engine boat) were used by fishermen for fish capture in the Buriganga river.

Biometrics, size at sexual maturity and natural mortality of the threatened carp *Botia dario* (Cyprinidae) in the Padma River, northwestern Bangladesh

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Abstract
The threatened carp *Botia dario* is an important valuable food fish in south Asian countries including Bangladesh, Bhutan, India and Nepal. This study describes the first complete and inclusive description of life-history traits of *B. dario*. .Samples were collected using different traditional fishing gears, including cast net, square lift net and gill net from July 2013 to June 2014. Total length (TL), fork length (FL) and standard length (SL) were measured to nearest 0.01 cm using digital slide calipers and total body weight (BW) was measured using an electronic balance with 0.01 g accuracy. A total of 142 specimens were collected, where 41.55% were males and 58.45% were females. The overall sex ratio did not differ significantly from the expected ratio 1:1 ($2=4.06$, $p>0.05$). TL was varied from 5.59 cm to 12.87cm and BW was ranged from 3.40 g-27.87 g. The calculated allometric coefficient (b) indicate negative allometric growth type in male, female and in combined sexes ($b<3.00$, $p<0.01$). All LLRs were highly significant ($p<0.001$) and most of the coefficients of determination (r2) values being >0.990. The WR was not significantly different from 100 for males and females ($p=0.908$). The vales of a3.0 were 0.0113 and 0.0101 for males and females, respectively. The Lm for male and female *B. dario* was 7.32 cm and 7.89 cm in TL. Moreover, the M was estimated to be 1.37 in the Padma River, NW Bangladesh. These findings would be very effective for the sustainable conservation of this threatened carp in Bangladesh and also neighbouring countries.

Life-history traits of the endangered carp *Labeo bata* (Cyprinidae) in the Padma River, northwestern Bangladesh

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Abstract
The minor carp, *Labeo bata* is commercially and nutritionally valuable food fish in Indian subcontinent and widely distributed in Bangladesh, India, Myanmar, Nepal and Pakistan. Previously it was abundant in rivers, canals, haors, baors, ponds and ditches, but the wild populations are seriously declining due to over exploitation, habitat loss and other ecological changes to their habitat and categorized as endangered in Bangladeshi waters. The present study describes the first complete and comprehensive description on life-history traits of *L. bata* including meristic and morphometric characteristics, length-frequency distributions (LFDs), length-weight relationships (LWRs), length-length relationship (LLRs), condition factors (allometric, KA; Fulton's, KF; relative, KR), relative weight (WR), form factor, size at first sexual maturity and natural mortality from the Padma River, NW Bangladesh. Samples were collected using different traditional fishing gears during July 2013 to June 2014. Sixteen lengths were measured to the nearest 0.01 cm and total body weight (BW) was measured with 0.01 g accuracy. A total of 304 individuals were collected, where TL varied from 7.9-25.2cm and BW ranged from 4.68-167.27g. All LWRs and LLRs were highly significant ($p<0.01$). The allometric coefficient (b) indicate positive allometric growth ($b>3.00$, $p<0.01$). All the condition factors (KA, KF, KR) were significantly correlated with TL and BW ($P < 0.001$). Form factor was 0.0108. The WR showed significant difference from 100 ($P < 0.001$) for this population. Size at first sexual maturity was estimated as 14.12 and 14.60 cm TL for males and females respectively. Natural mortality was 0.86 per year. The present study provides the first basic information on life history traits of *L. bata* from the Ganges River in northwestern Bangladesh. The findings of this research would be very effective for species life history and sustainable conservation of this endangered carp.

Comparison of the digestive tissues and esterase variability among three different fishes, herbivore (*Hypophtnalmicthyes molitrix*), carnivore (*Channa straitus*) and omnivore (*Mastacembelus armatus*) based on their food habits

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Abstract
Esterase isozyme is one of the lipid-hydrolyzing enzymes with multiple molecular forms and functions. It has a great significance in the field of fish genetics and technology. The present investigation compares of the digestive tissues and esterase variability among three different fishes, herbivore (*Hypophtnalmicthyes molitrix*), carnivore (*Channa straitus*) and omnivore (*Mastacembelus armatus*) based on their food habit. This study was done by 7.5% polyacrylamide gel electrophoresis. The electrophoretic banding pattern of esterase isozyme was examined in different digestive tissues, stomach, foregut, midgut, hindgut, liver and buccal muscle of three different fishes. Altogether 6 esterase bands were observed when, -napthyl acetate was used as substrate. Fast running esterase band was Est-1 (5.7) near to the anode pole (+) and slow running esterase band was Est-6 (0.6) near to the cathode (-) pole. This study revealed that the highest number of esterase band was found in the liver of omnivore (*M. armatus*) and lowest number of esterase band was found in herbivore (*H. moltrix*). Est-1 was less common and express in the liver of omnivore (*M. aramatus*) and Est-4 were most actively expressed among all the observed tissues. The present experimental observation indicates that herbivore fish shows less esterase activities compare with that of a carnivore and omnivore specially, when tissues from digestive organs were compared.

Morphological characterization of two cuchia- *Monopterus cuchia* (Hamilton, 1822) and Ophisternon bengalense (Mcclelland, 1844) found in inland water of Bangladesh

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Abstract
Morphometric comparison was carried out to evaluate the population status of two eels- *Monopterus cuchia* and *Ophisternon bengalense* collected from four different stocks. Morphometric, truss measurements and meristic characters from thirty two *M. cuchia* (collected from Mymensingh and Dinajpur), seventeen *O. bengalense* (collected from Bagerhat and Satkhira) were analyzed. The mean number of line below head were significantly (Mann-Whitney U test; z= -6.091; P<0.001) different between two species out of five meristic characters. Significant differences were observed in eleven morphometric characters Pre dorsal length (PDL), Post dorsal length (PoDL), Post anal length (PoAL), Head length (HL), Snout length (SnL), Upper jaw length (UJL), Lower jaw length (LJL), Head width (HW), Pre orbital length (PrOrL), Least body diameter (LBD), Highest body diameter (HBD) and one truss measurement (3-5) between two species in varying degrees. Plotting discriminant function DF1 and DF2 showed a clear differentiation between the species as well as between the stocks for both morphometric and landmark measurements, where the first and second DF accounted 64.8% and 33.2% of among group variability, explaining 98% of total group variability. A dendrogram based on morphometric and landmark distance data shows the populations of both the species constructed one cluster and further divided into two distinct sub-clusters. *M. cuchia* constructed one sub-cluster and *O. bengalense* constructed another sub-cluster based on the Distance of squared Euclidean dissimilarity. A correct classification of individuals into their original population from leave-one-out-classification varied between 93.3% and 94.1% by discriminant analysis and 95.9% of individuals could be classified in their correct priori grouping. Morphological characterization could be used effectively to know the population structure and taxonomic status. Both eels have high commercial value with domestic and overseas demand and their biodiversity should be conserved and brought under aquaculture to save them from extinction.

Reproductive cycles of endangered giant river catfish *Sperata seenghala*

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Abstract
Endangered giant river catfish, *Sperata seenghala*, is one of the important bagrid catfishes and was once abundantly available in Bangladesh. To conserve the biodiversity and develop suitable techniques for culture of *S. seenghala* it is essential to confirm the appropriateness of staging of gonad with histological examination, study the reproductive physiology of male and female through gonadal histology and finally to identify the peak breeding season. During the study period, the experimental fishes were collected month-wise (March-August, 2011) from catches of Sylhet basin. Routine haematoxylin-eosin (HE) staining of ovary and observation under microscope revealed oogonia, chromatin nucleolar, perinucleolar, yolk vesicle, early yolk granule, late yolk granule, pre-maturation stage and mature stages of oocytes. Early and developing stage oocytes were mostly observed during April-May, maturing oocytes in June, and mature oocytes during July-August. Testicular germ cells stages, such as spermatocytes, spermatids and spermatozoa were observed after HE staining of testes. Early and developing germ cells were mostly observed during April-May, gradually maturing in June, and mature germ cells during July-August sections of testes. Mature oocytes evident in ovary samples during July-August indicated mature phase of ovary ready to spawn. Again, appearance of most mature testicular germ cells in July-August samples is also supportive of the peak maturity of testes at the same time. The combination of ovarian and testicular histology summarizes that *S. seenghala* breeds during late monsoon. It is remarkable that, while many fish species from the fresh waters start to breed with the onset of monsoon, *S. seenghala*

Life history traits of the threatened fish *Esomus danricus* (Cyprinidae) in the Padma River, northwestern Bangladesh

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Abstract

The flying barb, *Esomus danricus* (Hamilton 1822) belongs to the family Cyprinidae, is a small indigenous fish species of Bangladesh. This species is widely distributed throughout the Indian sub-continent including Bangladesh, India, Nepal, Pakistan and Sri-Lanka. This barb inhabits in ponds, weedy ditches, streams, beels, inundated fields and the wild populations are declining due to heavy harvest, habitat loss and other ecological changes to their habitat and therefore, categorized as threatened in Bangladesh. The present study describes the life-history traits including length-frequency distribution (LFD), length-weight relationships (LWRs), length-length relationships (LLRs), condition factors (Allometric, KA; Fulton's, KF; Relative condition, KR), relative weight (WR), form factor (a3.0), and size at first sexual maturity (Lm) of the *E. danricus* from the Padma River, northwestern (NW) Bangladesh. Sampling was done by using traditional fishing gears including cast net, square lift net and conical trap, during May to October 2013. For each individual, lengths (TL, FL and SL) were measured with 0.01 cm accuracy and total body weight (BW) was taken with 0.01 g accuracy. A total of 309 individuals ranging from 2.94-6.10 cm TL and 0.30-1.31 g BW were analyzed in this study. The LFD showed that the 4.0-4.99 cm TL size group was numerically dominant in our study area. The allometric coefficient (b) of the LWRs indicated negative allometric growth ($b < 3.0$). All LLRs were highly correlated ($p < 0.001$). The KF ranges from 0.56 to 1.18 and minimum and maximum WR was 85.76 to 116.67. In addition the WR was not significantly different from 100 ($p=0.074$) in the Padma River. The a3.0 was calculated as 0.0138 and the Lm was estimated as 3.98 cm TL in the Padma River. Our findings would be very effective for fishery biologists and conservationists for sustainable management and conservation its numerous stocks in the region.

Population biology of the threatened catfish *Mystus cavasius* in the Padma River: Recommendation of conservation

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Abstract
The threatened catfish *Mystus cavasius* is one of the commercially high nutritional valuable fish in Asian countries but the natural populations are seriously decreasing due to high fishing pressure, leading to an alarming condition and deserving of high conservation importance. The present study describes population biology including sex ratio, relative growth, condition factors, size at first sexual maturity, spawning season and fecundity of *M. cavasius* in the Padma River, Bangladesh. Sampling was done using traditional fishing gears during July 2013 to June 2014. Total length (TL) was measured to the nearest 0.01 cm, and total body weight (BW) was measured with 0.01 g accuracy. Additionally, whole gonads were removed from each individuals and weight with accuracy of 0.01g. The length-weight relationship was calculated as W= a Lb, where W is the BW, L the TL. Gonad somatic index was calculated as GSI (%): 100*(GW/BW), where GW is gonad weight. A total of 1200 specimens ranging from 5.02-15.80 cm TL were analyzed. The overall sex ratio showed no significant differences from the expected values of 1:1 ($P > 0.05$). The allometric coefficient b for the LWR indicated isometric growth (b~3.00) in males and combined sexes, but positive allometric growth (<3.00) in females. Size at first sexual maturity was considered to be 7.5 cm TL male and 8.00 cm TL for female. Spawning season of *M. cavasius* extends from April to July with a peak during May and June in the Padma River. This study suggested that fishing of *M. cavasius* size at first sexual maturity should be completely stopped during the peak spawning season for its conservation. The results of this study should be useful for the sustainable conservation of this threatened fish in Bangladesh and neighbouring countries.

Determination of the diversity of plankton and benthic fauna and their relation with physico-chemical parameters from three water bodies

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Abstract
Plankton and benthic communities are very important components of aquatic ecosystems as they set the base of the aquatic food chains, maintain associated biodiversity and proper ecosystem functioning. Their diversity and abundances depend on the water quality that indicates the condition of ecosystem health. The study was conducted to assess the diversity and abundance of the zooplankton and benthic fauna in different water bodies and to relate these with the water quality. The samples were collected from three different water bodies of Birulia Union under Savar Thana, Dhaka viz. i. a pond (23°51.582'N, 90°17.501'E), ii. a beel (23°51.241'N, 90°20.050'E) and iii. Turag River (23°51.099'N, 90°20.320'E) between March 2013 and January 2014. Water samples and sediments were collected from different parts of each water body, screened in the field and later, examined in the laboratory. Water temperature, pH, Dissolved Oxygen (DO) and transparency were also measured. A total of 23 different species of Planktons and 6 different genera of benthos were found in the pond; which were 23 & 9 in beel and 6 & 9 in river respectively. pH and DO, among others, ranged

from 6.5-9.8 and 0.3 mg/l -9.7 mg/l in pond, 6.6-9.6 and 1.6 mg/l-10.7 mg/l in beel and 6.5-9.6 and 0.3 mg/l-10.8 mg/l in river respectively. The species richness was found less and water quality was unfavourable for aquatic organisms in Turag River (except monsoon days) indicating its polluted situation. The study has the potentiality in understanding the status of the aquatic ecosystems and evaluating their changes in future. Furthermore, it will also help in conserving the aquatic resources through understanding the impacts of different development activities like dredging, dumping and industrialization on aquatic habitats as well as their related biodiversity.

Phenotypic diversity in eighteen summer grown eggplant (*Solanum melongena* L) genotypes in Bangladesh

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Abstract
Eggplant (*Solanum melongena*) is an important and popular vegetable crop of Bangladesh. The success of effective breeding program depends much on the genetic variability available to the breeders and the judicious selection of the breed. The present study was undertaken to find out phenotypic diversity of collected eggplant genotypes, to identify the most diverged genotypes in relation to quantitative characters, which contribute the most towards divergence of the genotype. Phenotypic divergence in eighteen eggplant genotypes was studied at BSMRAU, Gazipur, Bangladesh during March 2007 to November 2008 using multivariate analysis. Among the 18 genotypes wide variations were observed for plant, flower and fruit. Among them only 8 were found to be suitable for summer season cultivation. The studied genotypes were grouped into four distinct clusters. Cluster I comprised 2 genotypes, cluster II had 3, cluster III had 3 and cluster IV had 10 genotypes. The highest inter cluster distance was between cluster I and IV (764.67) while it was the lowest between cluster II and III (213.30). The highest and lowest intra cluster distance was displayed in cluster II (94.14) and cluster I (28.79) respectively. Fruit number and yield per plant, plant canopy, fruit weight, fruit length and number of harvest had the highest contribution towards total divergence. Vegetative characters had high diversity among the genotypes, while it was moderate to high diversity for both flower and fruit characters. Considering genetic diversity eight genotypes were selected for summer cultivation, which could be used in future hybridization program.

Butterflies of Chuadanga District, Bangladesh

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Abstract
Chuadanga district is situated in western part of Bangladesh and it has an important habitat for butterflies with many fruit gardens, agricultural fields, homestead vegetation, flower garden, weeds, wild herbs and shrubs contain huge number of varieties. A study was conducted in this district during November 2011 to April 2014. The objective of this study is to investigate the butterfly diversity, status and to contribute the butterfly checklist of Bangladesh with established a permanent database. The habitats were documented randomly by visual observations, walks, opportunistic observations and species were also photo-documented. A total of 48 species of butterflies belonging to six families were recorded for the first time. The family Nymphalidae was found to be dominant with 17 species followed by Lycaenidae (10 species), Hesperiidae (10 species), Pieridae (06 species), Papilionidae (05 species) and Riodinidae (01 species). This study will helpful for studying the overall documentation and distribution pattern of butterflies of this country.

Comparison of nest characteristics of White-throated Kingfisher (*Halcyon smyrnensis*) in Dhaka and Chittagong

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Abstract
A study was done on 'Comparison of nest characteristics of White-throated Kingfisher (*Halcyon smyrnensis*) in Dhaka and Chittagong' from September 2008 to September 2011. The study sites were Bangladesh National Museum in Shahabag and the village of Madhabchala, Bara Walia and Sinduria in Savar Upazilla and Chittagong University Campus (CUC). It was performed to investigate the comparison of nest location, measurement and threats in different environments. The study was done by direct field visit. The areas were visited twice in a week whenever the nest was identified during breeding season. They built nest by making hole in sandy loam area and nearly 90o sloppy walls. They built a good number of false nests beside the true nests (33.3 % in CUC and 90% in Dhaka). The true nest ended in a widened egg chamber. The nest was situated 56 to 126 cm below from the top of the ground in CUC and 33 to 132 in Dhaka and 31 to 1524 cm up from the base of the ground in CUC and 38 to 94 cm in Dhaka. The nest depth was 58 to 86 cm in CUC and 14 to 65 in Dhaka. The horizontal diameter of outer opening of the nest was 6.5 to 14 cm in CUC and 7.1 to 13 in Dhaka whereas the vertical opening was 7.5 to 12 cm and 8.9 to 12 cm respectively, the horizontal diameter of the egg chamber was 18 to 21 cm and 11 to 20.7 whereas the vertical diameter was 12 to 16 and 10 to 13 cm in CUC and in Dhaka respectively. Number of false nest building and reuse of old nest varied according to disturbance of the nesting site. Human disturbances, nest destruction and habitat destruction were the main threats.

Identification of parasites in fishes; potential in biodiversity conservation

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Abstract
Parasites, constituting more than half of all biodiversity, are the integrative core of biodiversity survey and inventory, conservation and environmental integrity and ecosystem function. In the realm of conservation biology parasites have dual and conflicting significance; because they may regulate host populations, at the same time, they represent threats to human health, agriculture, natural systems, conservation practices, and the global economy. Parasitic disease is the single most important factor threatening the fishery industry worldwide, particularly in the tropics. In Bangladesh, the *caryophyllidean cestodes* are parasitic in important catfishes like walking catfish- *Clarias batrachus*, stinging catfish- *Heteropneustes fossilis*, pabda catfish-Ompok pabda, Garua bacha-Clupisoma garua (Ham.) etc. The revision of *caryophyllidean cestodes* parasites in the catfishes of Bangladesh were investigating by based on survey of several newly collected specimens as well as previously described specimens. *Caryophyllidean cestodes* were collected from different catfishes which were mostly collected from the Mymensingh district and also from few other districts of Bangladesh. The parasites were isolated from the host intestine and prepared very carefully for their morphological study. Related literatures on caryophyllidean cestode parasites of Bangladesh were also collected from different journals. In spite of a number of species described sporadically by different authors only eight species belonging to five genera of caryophyllidean cestodes are considered to be valid. The recognized species are- *Djombangia penetrans* (Bovien, 1926), *Lytocestoides pabdai* Biswas, Chandra and Das, 2006, *Bovienia serialis* (Bovien, 1926), *Lytocestus birmanicus* Lynsdale, 1956, *Lytocestus indicus* (Moghe, 1925) Woodland, 1926, *Lytocestus parvulus* Furtado, 1963 *Pseudocaryophyllaeus indica* Gupta, 1961 and *Pseudocaryphyllaeus heteropneustus* Chandra and Khatun, 1993. The identification of parasites from fishes can be sensitive indicators of subtle changes within ecosystems as well as its biodiversity.

Food consumption and feeding habits of hatchlings and adult saltwater crocodile (*Crocodylus porosus*) in a crocodile farm of Bangladesh

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Abstract
An extensive study was conducted on food consumption and feeding behavior of saltwater crocodile (Crocodylus porosus) in the Reptiles Farm Ltd. (RFL) located at Hatiber village, Bhaluka, Mymensingh. The study was mainly based on direct field observation and previous data collected by the technicians of the RFL. Average temperature (0C) in the farm area was significantly correlated with average food consumption (g) of the hatchlings ($r=0.714$, $p<0.05$, $n=12$). The average temperature and the average food consumption were highest in August and it was 30.5 ±5.5 0C and 45.02 ±13.05 g, respectively. Monthly feeding of hatchlings was different in three individual tubs. The highest food consumption was in August although; hatchery's temperature was constant (320C).Crocodilians can increase their level of consumption during warmer months of the year while decreasing it in the cooler months. The highest quantity of food was given in October, probably for accumulation of fat in their body which would provide energy in the whole winter season. A total of 93.1 kg provisioned food was supplied to an adult crocodiles per year. Food consumption of crocodile is temperature dependent and the potentiality of crocodile farming is embedded in it, by considering this factor it may gain prosperity of crocodile farming in our country.

Fishers' perceptions towards Hilsa protected areas in Bangladesh

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Abstract
Fish sanctuaries were declared to conserve parts of an ecosystem for long term sustainability of fisheries resources and respective livelihoods. For management effectiveness of protected areas, it is important to achieve fishers' acceptance of sanctuaries. Small- scale fishers from four Hilsa protected areas in Meghna estuary were interviewed to investigate their acceptance and to elicit their perceptions regarding protected areas. Using a semi-structured questionnaire, interviews were conducted in four fishing communities: Ilisha in Bhola district, Puraton Hizla and Laharhat in Barisal districts and Kalapara in Potuakhali district. The results showed that the majority of fishers at each study areas view protected areas as good for Hilsa fisheries conservation; however non-compliance of conservation laws is also rampant that lead to over exploitation of Hilsa fisheries. A number of reasons were identified for illegal exploitation. Poverty, cycle of indebtedness to money lenders and NGOs, greediness of local powerful fishing entrepreneurs, corruption of government officials are commonly cited causes for continuing fishing during prohibited seasons. For effective management of protected areas, a combination of input and output control is suggested and community-based management of the protected areas was preferred. This study make a contribution to the existing practice by shedding light on different aspects that can make the management strategies of Hilsa protected areas of less effective. By taking consideration of the study findings, appropriate management strategies of Hilsa protection could be undertaken.

Population of the Ganges River dolphin (*Platanista gangetica* Roxburgh, 1801) in the major River systems in and around Pabna, Bangladesh

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Abstract
The Ganges River Dolphin (*Platanista gangetica* Roxburgh, 1801) is one of the most charismatic mega-fauna and an endangered freshwater cetacean species of Bangladesh. The study was conducted in the three major rivers (Padma, Jamuna and Hurasagor) in Pabna district during October 2012 to September 2013. The goal of the study was to estimate the population abundance of the Ganges River Dolphin in the Padma, Jamuna and Hurasagor rivers. Five transects was followed to estimation the species' population through direct observation from the engine boat and questionnaire survey to the people. A total of 210 dolphins were recorded in the entire 78.75 km of rivers with an encounter rate of 0.23 dolphins per km. Variations in water depth of the river appeared significant in the presence of dolphins. The highest number of dolphins was found in parts of river with depth range of 10.1-12 meters in the Padma River and 12.1-14 meters in the Jamuna River. The observation of dolphins showed that adults consist 82.7% and young consist 17.2% of the population. The population and habitat of dolphins are degraded day by day and the dolphin abundance is declining rapidly, so continuous monitoring is recommended to save this species.

Spatial and temporal dynamics of phytoplanktons and their relationship with environmental variables in four eutrophic ponds in Mymemsingh

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Abstract
A study was carried out to assess the plankton diversity in four eutrophic ponds and their relationship with physico-chemical parameters in both spatial and temporal scales. Plankton samples were collected along with water quality parameters from January 2012 to December 2013. During the study period, a total of 23 genus from six classes, Cyanophyceae, Euglenophyceae, Chlorophyceae, Bacillariophyceae, Ceratiaceae and Peridiniaceae were determined. Species composition of phytoplankton was typical of eutrophic conditions and was frequently characterized by the presence of Cyanophyceae . Diversity status was analyzed by using PAST (version 2.17) software. Finding showed that Microcystis sp., Ceratium sp., Tracheolomonas sp., Lepocinclis sp., and Spirulina sp.were the major contributing species (17%) for season basis. Analysis of Similarity (ANOSIM) results showed spatial differences and low temporal similarity in species community structure with a diverse assemblage. Canonical Correspondence Analysis (CCA) has been carried out to show the relationship among spatial and temporal data.

Temporal and spatial fish and shrimp assemblage of Estuarine Set Bag Net (ESBN) in Gabkhan channel of Pirojpur district with reference to some water quality parameters

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Abstract
The fish and shrimp assemblage was analyzed along Gabkhan channel of Pirojpur district. Species diversity of the channel was totally uninvestigated before this research. Species were collected from two stations of this channel in every season from premonsoon 2011 to winter 2011 using Estuarine Set Bag Net (ESBN). For each sampling, some environmental factors (water temperature, dissolve oxygen, pH, water transparency and total suspended solids) were recorded. Through the study, 60 species belonging to 30 families were recorded. *Macrobrachium mirabile* (21.54%) was

found the most abundant species in the channel followed by *Odontamblyopus rubicandus* (12.26%) and *Exhippolysmata ensirostris* (8.76%). The diversity indices, SIMPER and ANOSIM analysis exhibited high seasonal diversity of species in Gabkhan channel. Cluster and nonmetric multidimentional scaling (nMDS) analysis defined four distinct groups showing temporal variation of the channel. Canonical correspondence analysis (CCA) showed the influence of environmental variables in structuring species assemblage. This research has highlighted the high diversity in Gabkhan channel, so further study should be continued in this navigation channel.

Availability and consumer preference of catfish in Rajshahi city area

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Abstract
Field survey was carried out in over four fish markets namely Shaheb bazar fish market, Laxmipur fish market, Horogram fish market and Shalbagan fish market at Rajshahi from March 2010 to January, 2011. The main source of these cat fishes were Padma river, beels and adjacent floodplains in Rajshahi area. A total of 22 species of catfish are available in Rajshahi city area of them 11 were not in the IUCN red list, 3 were vulnerable, 3 were endangered and 5 were critically endangered. There were mainly 3 types of marketing channels for catfish marketing of which fishermen-consumer, fishermen-aratdar-retailer-consumer and fishermen-aratdar-wholesaler-retailer-consumer were noted. Highest and lowest average price were Tk. 606.83/kg and Tk.261.92/ kg for *Bagarius bagarius* and *Clupisoma garua*, respectively. Average fish intake was found as 80 gm or above/day (18%), 60-80gm/day (22.66%), 40-60 gm/day (28.66%), 40 gm or below/ day (30.67%). The reason for consuming catfish was found as taste (48%), freshness (19.33%), nutritive value (15.33%), less bony (5.33%), availability (5.34%). In the current study it was found that 43.99% people preferred Indian major carp for consumption. The most preferred sources to consumers for catfish consumption were found as Padma river (78%), beel (8%), any other rivers (12.67%) and different other sources (1.33%).

Use of Mahogany (*Swietenia mahogani*) Seed Oil for Eradicating Backswimmers (*Notonecta sp.*) from Nursery Pond

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Abstract
The objectives of this study were to investigate the effective use of mahogany seed oil as an alternative conventional pesticide to eradicate backswimmers from nursery ponds. Beside, the biological assay of mahogany seed oil and Sumithion on Stinging Catfish-Shing (*Heteropneus tesfossilis*) larvae was tested. We conducted the study at backyard hatchery of Fisheries Faculty, Bangladesh Agricultural University, Bangladesh during the late monsoon (August), 2013. Eight aquaria (30inch × 18 inch × 18 inch of each) marked as (i.e., T-Treatment) T1 (0.06ml/100L), T2 (0.125ml/100L), T3 (0.25ml/100L), T4 (0.50ml/100L), T5 (1.0ml/100L), T6 (2.0ml/100L) for mahogany oil, T7 (0.06ml/100L) for Sumithion and C (0ml/100L) for control to observe the effects on backswimmers. We also used 3 aquarium (30inch × 18 inch × 18 inch of each) and they were marked as M (0.06ml/100L) for mahogany seed oil, S (0.06ml/100L) for Sumithion and C (0ml/100L) for control to observe the deformities during larval development of shing. We assessed the LC50 for mahogany seed oil and sumithion on back swimmers were 19, 15, 11, 7, 6, 5, 150 and 1068 minutes for T1, T2, T3, T4, T6, T7 and control. Mortality was considered as an endpoint. Mahogany seed oil did not show any deformities in shing larvae but Sumithion showed some deformities such as notochord deformity, swell body formation and tissue deformations. The mortality rates (%) of Shing larvae were 57.5% for M, 71.25% for S, and 48.5% for C. The findings from the research will generate to use Mahagony seed oil in nursery ponds to eradicate aquatic insects rather than Sumithion.

Theme 2: Papers

Species & Habitat Protection:

Necessity of Science based Policy and Governance

Protected Area governance- a new approach to make conservation count towards sustainable livelihoods

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Abstract
Globally conservationists, policy makers and implementing agencies came to a consensus that conservation of natural eco-systems requires local community involvement not only for protecting the biodiversity but also creating sustainable job opportunities and livelihoods. This approach is consistent with the global movement towards conservation models that include eco-tourism, scientific research, and environmental education including forestry, wildlife, and fisheries. In this respect, Tangail Forest Division (TFD) has set a benchmark by engaging the local communities into the conservation of Madhupur forest. TFD has successfully implemented the concept of eco-agriculture in creating jobs for the locals. "Revegetation of Madhupur forest through Rehabilitation of Local and Ethnic communities" project has been established as a protected area conservation friendly scheme where the community forest workers (CFW) are trained with various Alternative Income Generation (AIG) activities. In addition, TFD has brought under reforestation of 1520 hectares of encroached forest land with native plants. Moreover, 5000 forest dependent families planted 200 saplings, established kitchen gardens and a compost plant. They have improved their stoves and focused on rearing cattle in their own homestead. Furthermore, free health care facilities and registered co-operative societies have been formed. With this approach of linking communities to conservation and development activities, logging and poaching has declined significantly and the forest is now rejuvenated with flora and fauna. So, to protect the important natural ecosystems and biodiversity steps need to be taken to support AIG for the livelihoods of local people and their needs. These effective approaches are replicable to ensure social, environmental and economic sustainability of forests.

Key words: *protected area, governance, conservation, forest-dependent community, livelihoods, alternative income generation*

Introduction:
Worldwide protected areas (PA) have been declared as a response to uncontrolled degradation of biodiversity and ecosystem services following the trend of Yellow stone National Park in 1872 (Lane 2001, Pretty and Smith 2004, Chape et al. 2008). Likewise, to date, a total of 38 PA of Bangladesh have been declared and in most, PA management follows the same conventional and exclusionary top-down approach applied at Yellow stone in 1872 (Lane 2001, Pretty and Smith 2004). Ironically, most PA management has failed to consider other important factors, including social, cultural, and political issues (Andrade and Rhodes, 2012). However, the importance of incorporating a more participatory approach into PA decision-making processes in order to foster the implementation of conservation strategies (Brown 2003, Grainger 2003, Pretty and Smith 2004, Anthony 2007, Reed 2008) and thus to count PA conservation towards sustainable jobs and livelihoods has been widely recognized. Following the current IUCN definition of the Protected Area and based on management objectives IUCN categories PA, National Park falls into Category II that emphasis more on sympathetic management for its biodiversity protection (IUCN, 2011). Furthermore, carefully managed protected areas have been shown to alleviate poverty; conserve biological resources whilst providing developmental benefits to marginalized communities (WWF and Equilibrium, 2008).

In this respect, Tangail Forest Division (TFD) has followed this contemporary trend of PA management while introducing a unique dimension in participatory approach. The TFD policy was to identify people who were involved in illegal tree felling, motivate and train them and transform them into guardians of the forest as a 'Community Forest Worker' (CFW) who would work in parallel with the forest staff. This has also helped to fix inadequate staff issue and bridged the gap between the forest frontiers and the locals. Although initially TFD struggled to pull everything together because of hostile local community and other administrative adversity, TFD has worked hard to acquire encroached land and motivate the local community towards conservation in parallel.

It has been argued that although PA co-management initiatives have the potential to enhance adaptive capacity of the forest communities it's not a policy panacea (Koli, 2010). In this paper, we will argue that local forest institution can only be effective if the locals are provided with sustainable livelihood opportunities. By installing cooperative institutions that include health cooperatives and encouragement to train in alternative income generating activities within these exclusively forest dependent ethnic communities we demonstrated that their society can thrive and grow.

Identification of the issues behind the degradation of Madhupur forest and finding the ways to tackle these:

Once biodiversity rich Madhupur Forest has been degrading since 1950. This was due to indiscriminate timber-fuel collection, poverty of the forest dependent communities, greed, forest land encroachment and unrealistic traditional management approaches by the forest management authority. At the point when the situation had worsened drastically and management authority was continuously failing to address the issues, TFD launched a new project titled Revegetation of Madhupur Forest through Rehabilitation of Forest Dependent Local and Ethnic Communities with the broader aim of protecting forest, sharing resource management with forest communities and ensuring the livelihood security of the forest communities. The three year project was initiated in the year 2010 initially and has already been extended to 2015 due to its continuous success. The major activities of the project are:

- Identification and selection of the completely forest dependent local communities which were directly involved in forest and its biodiversity destruction
- motivate and train the locals
- engage the locals in alternative livelihood activities
- revegetate the degraded forest land
- support the locals with various facilities, like, homestead plantation, improved stove, vegetable garden, cattle rearing, compost plant, health and family planning etc.
- establish the Govt. registered co-operative societies.

Key Findings:

Effective paradigm shift of forest management:
The basic concept behind this paradigm shift of forest management is pluralism. It is important for sustainable forest management to engage the stake holders from different arenas into conservation and development activities. This includes forest resource users, ethnic communities, Bengali communities, different organizations, and elite groups. All of these groups were involved in various stages of consultation and acting together for Madhupur forest conservation and protection.

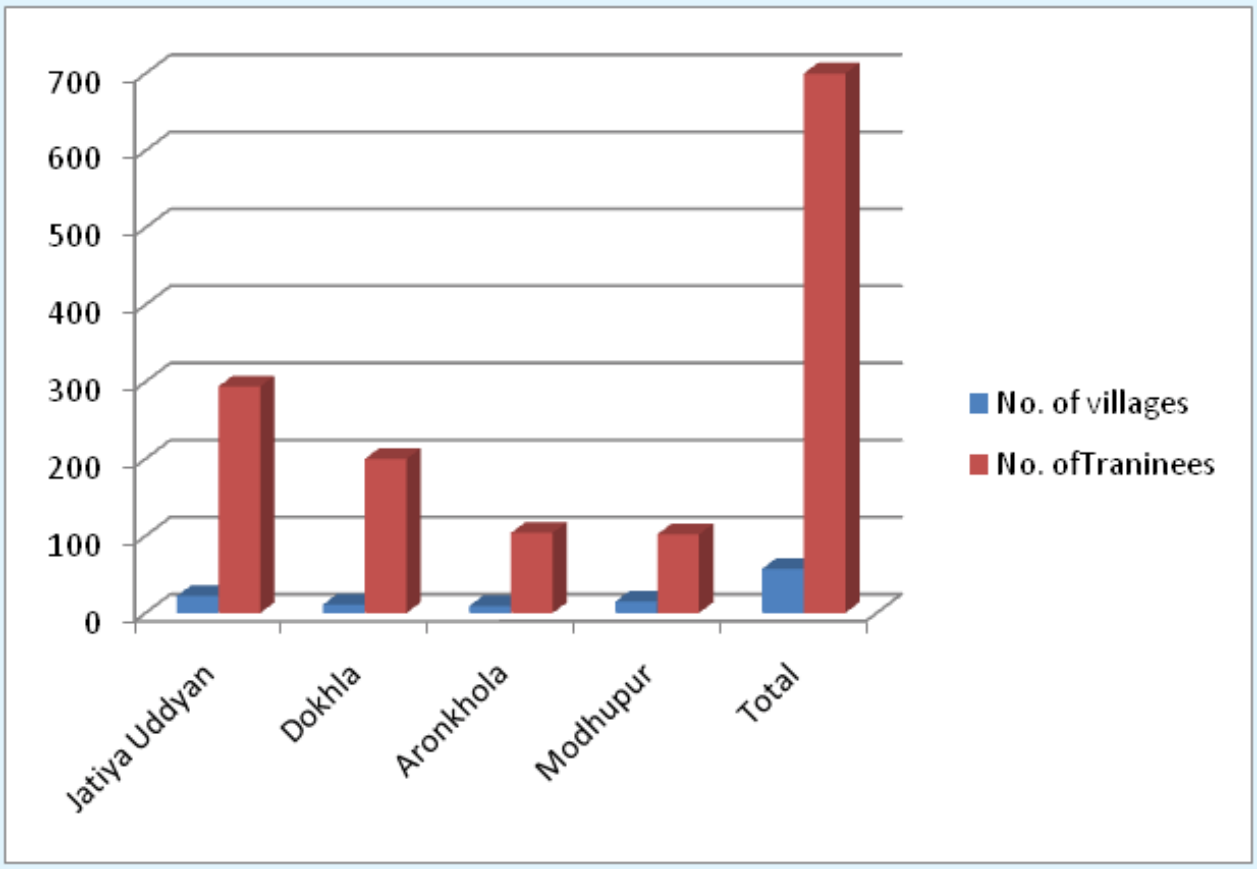
Motivated and Trained local communities:
In relation, Tangail Forest Division identified a total of 700 forests dependent individuals from 57 villages of the Madhupur forest. Four different Forest Ranges were trained up in different income generating courses. During the training period each participant got 4,500/- taka per month as training allowance. The trainees were also been given full set of uniform, identity card and other training materials. To uplift the living standard and to reduce dependency on the forest by enabling them self-dependent extensive motivational workshops and training on various income generating courses were conducted.

Table 1: detailing the no. of trainees from different villages under 4 ranges of Madhupur Forest

Forest Range	No. of villages	No. of trainees
Jatiya Uddyan	22	294
Dokhla	11	200
Aronkhola	9	104
Madhupur	15	102
Total	57	700

The training courses included nursery raising &reforestation, Mushroom cultivation, Poultry and Dairy, Apiculture, Pisiculture, Vegetable gardening, Compost preparation, Jam, Jelly, Juice preparation, Motivation to change attitude, Forest fire protection etc. Trainers possessed various perspectives, like, experts in concerned areas, public representatives, political leaders, journalists, Govt. officials, NGO representatives and academicians. After receiving training the trainees have been treated as Community Forest Workers (CFW).So now they have already given up their old profession and they have been merged in the mainstream of the society.

Fig 1: Showing the no. of trainees in four different ranges of Madhupur Forest



Moreover, as part of the program, a total number of 5000 forest dependent families have planted 200 different kind of saplings (50 nos. of fruit, 50 nos. of timber and 100 nos. of fuel wood species.) in their own homesteads and now are enjoying the benefits of harvesting vegetable, fruit and fuel wood from their premises. As a result, the dependency over forest is being gradually reduced and their livelihood becomes secured.

Reduce Forest offences:

The real causes of destruction of Madhupur Forest have not been rightly diagnosed. Only those who felled trees in the forest have been blamed for the forest destruction. Huge cases have been filed in court against them (Table-2). The new policy has been able to lessen the gap between local ethnic and Bengali community and build up confidence. Positive attitude has been developed among people of Madhupur. Forest offence had been reduced dramatically. After getting training, these forest dependent people are now called "Community Forest Worker (CFW). Once these CFW were involved in illegal felling, encroaching forest land and other illegal activities.

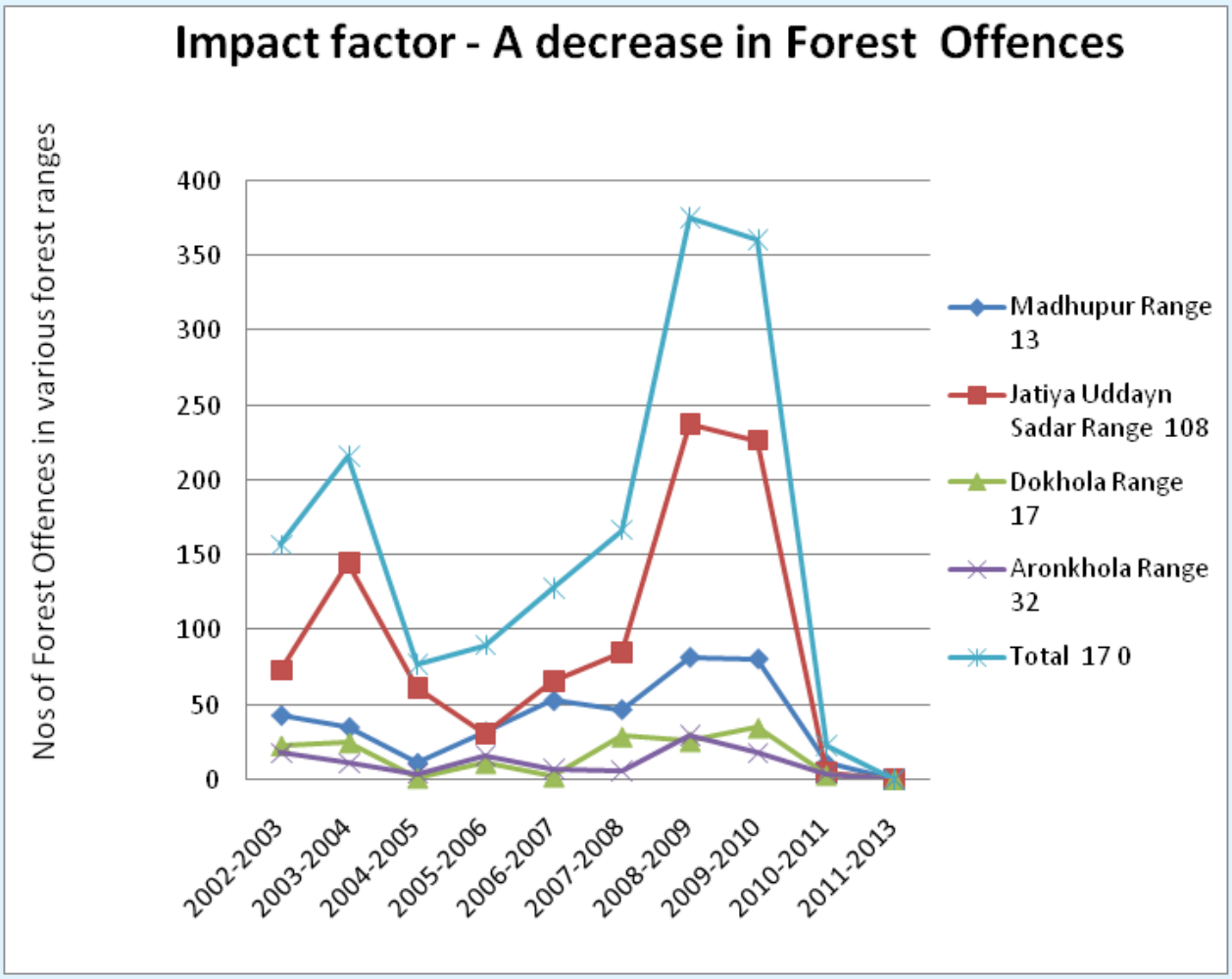
Table 2: No. of forest offences filed in last 13 years

Year	Madhupur Range	Jatiya Uddayn Sadar Range	Dokhola Range	Aronkhola Range	Total
2001-2002	13	108	17	32	17 0
2002-2003	43	73	23	18	157
2003-2004	35	145	25	11	216
2004-2005	11	61	1	4	77
2005-2006	32	31	11	16	90

Year	Madhupur Range	Jatiya Uddayn Sadar Range	Dokhola Range	Aronkhola Range	Total
2006-2007	53	66	2	7	128
2007-2008	47	85	29	6	167
2008-2009	82	238	26	30	376
2009-2010	81	227	35	18	361
2010-2011	11	5	3	4	23
2011-2012	0	0	0	0	0
2012-2013	0	0	0	0	0
2013-2014	0	0	0	0	0

After having training a sense of ownership has developed with the CFWs and local communities. Their extended involvement and support is evidenced in the reduction of forest offences which have come down to zero. Moreover, now CFW are working along with the forest guards to protect and conserve the Madhupur forest. I

Fig. 2: Forest offences has come down to zero in all ranges of Madhupur Forest



Sustainable livelihood:

About 5000 Forest dependent families have planted 10, 00,000(1.0 million) trees on their own premises and holdings, ensuring increased green coverage of Madhupur. In the long run, when these trees will be established, these forests dependent people will get fruit, timber and fuel wood from their own premises. They have been getting vegetable from their kitchen garden, bio-fertilizer from the compost plant and benefits from cattle. Consequently, their dependency on forest is being reduced gradually and after some period these people will be self-dependent regarding fruit, timber and fuel wood consumption. Moreover, each of the selected forest dependent family are now enjoying environmental friendly home by eliminating all wastes and taking all sanitation measure. They are going to be self sufficient by involving themselves in different income generating activities, like, commercially planted pineapple and banana and plantation with commercial species which will gradually eradicate poverty of forest dependent Bengali and ethnic people. Through training their income generating skill has been developed. They are now working as firewatcher, daily laborer, mushroom cultivator, vegetable gardener, Van puller, small business man. In addition, use of compost fertilizer reduced the use of chemical fertilizer, retain fertility of land. To boost up their confidence and engagement, improved stove has been installed in their houses and health card has been given to them for regular health check-up for free.

Table 3: Table showing the percentage of trained people (CFW) who has taken up new profession

Current Profession	Percentage (%)
Nursery	15
Jam/Jelly/Juice Production	12
Pisiculture	15
Poultry & Dairy	8
Van/Rickshaw puller	20
Cattle rearing	15
others	15

Rejuvenated forest:

Massive destruction of Madhupur forest cost a fortune. About 45,565 acres vegetation cover has shrunk down to around 10, 000 acres. Previously, Madhupur Forest was consisted of 70 to 75% Sal (*Shorea robusta*) but due to illegal felling of both trees and copies it has almost lost its original feature. The forest land that has been degraded depleted as well as encroached by the local people who have brought it under plantation program. During the project period, 1530 hectares of degraded forest land have been planted mostly by the native species. The plantation program was done in different Mouzas under forest beats shown in the Table 3.

Table 4: Plantation status of the forest in the year 2010 to 2014

Range	Beat	Mouza	Planted area (hac) 2010-14	Species
Jatiya Uddayn Sadar	Sadar	Aronkhola	126	Mehagoni, Arjun, Sal, Gamar, Teak, Gorjon, Koroi, Chikrashi, Neem, Jam, etc.
,,	Gachabari	Gachabari	53	
,,	Rajabari	Rajabari	136	
"	Baribaid	Baribaid	254	
"	Lohoria	Aronkhola	61	-do-
Dokhla	Sadar	Aronkhola	85	Mehagoni, Arjun, Sal, Gamar, Teak, Gorjon, Koroi, Chikrashi, Neem, Jam, etc.
		Pirgacha		
"	Chadpur	Fulbagchala	235	-do-
Madhupur	Charaljani	Chonoia, Baribaid	202	-do-

Range	Beat	Mouza	Planted area (hac) 2010-14	Species
"	Mohish-mara	Chunia, Mohish-mara, Bathbari, Haldia	348	-do-
		Total	1500 +30	Different types of fruit sps spp. for animal & birds

This has helped the forest to increase vegetation cover which in return has helped to enrich both plant and animal diversity.

Regaining biodiversity:

Undisturbed Madhupur forest has helped the forest floor to be rejuvenated with numerous species which is a good sign of a reviving biodiversity. Once again, wildlife is getting Madhupur forests as its secured home. Hence, the ethnic communities are not involved in hunting and poaching of wildlife to meet their daily protein need, as, now they are involved in poultry and pisiculture and other professions. A recent bird species survey has identified about 48 species of birds of which 31 species of birds are common resident, 11 species of birds are very common resident, 6 species of birds are uncommon resident and. Moreover, reports of sighting of once lost wildlife has been confirmed by the forest frontiers and wildlife biologists. Now, forest dependent people are experiencing the increase number of wildlife.

Conclusion:

A positive attitude regarding conservation of Madhupur forest has been created among most people concerned. Continuous monitoring relieved Madhupur forest from its destruction by fire during dry season. Control of this fire has also aided in the ability of different plant species to generate naturally. Lack of proper management and engagement with the local community contributed to the destruction of the forest in the past. However, TFD's timely and efficient engagement and management practices have paved the way for the Madhupur forest regaining its lost status.

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Compliance of biodiversity conservation policy on coastal fisheries resources in Bangladesh

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Abstract

Almost 25% of the global vertebrate diversity is accounted by fish and fish species threatened in Bangladesh was last measured at 18 in 2013 by the World Bank. IUCN (2004) listed 13 threatened fish species in our coast including Sundarbans. Moreover, the Swatch of No Ground has now been identified as a cetacean hotspot for globally endangered Ganges River and Irrawaddy dolphins, and very recently government has declared its first marine protected area in the Bay of Bengal. Bangladesh is a signatory to about 28 environmental treaties, conventions, and protocols. In addition, species conservation issues are taken as forefront activities by concerned agencies of the government. The Bangladesh National Biodiversity Strategy and Action Plan (2010) is an initiative as a national obligation to the Convention on Biological Diversity and Biodiversity Programme of Action 2020 identified 9 focal areas, of which coastal and marine ecosystems conservation ranks the top priority. Although Wildlife Act (2012) described 30 shark and rays species including sea horse, 6 species of whale, 14 species of dolphins, 22 species of crab and lobsters as protected marine species, the diversity of those species in our water bodies is in doubt. There is a lack of information on the species diversity in the coast. The management of coastal and marine biodiversity in Bangladesh is its responsibility and also an exclusive task of the neighboring countries of Bay of Bengal and Indian Ocean rim countries. Despite the country has number of strong policies and plans to protect environmental and biological resources, it is continuously losing its biodiversity because of their poor implementation and also due to human ignorance. We failed to recognize biodiversity as a rich and essential source of our nutrition and livelihood. In depth study need to be conducted to obtain information on the status of coastal fish biodiversity, abundance and stock size towards effective compliance of conservation measures.

Introduction

Bangladesh has the world's longest beach (710 km) along the Bay of Bengal (BoB), filled with a rich and unique coastal biodiversity. On the other hand, the Sundarbans has the unique distinction of being one of the world's largest contiguous stretches of mangrove forests. Fish as a group, apart from its economic value, from a biodiversity viewpoint, has the highest species diversity among all vertebrate taxa. It is believed that out of 61,259 species of vertebrates recognized world over, 32,300 are fish species; of which 16,764 are marine (William et al. 2010). A number of coastal areas and ecosystems in Bangladesh are under stress due to growing aquaculture, agriculture activities and other anthropological activities. Natural causes affecting coastal biodiversity have also been of concern in recent years.

Marine and coastal biodiversity of Bangladesh

Bangladesh is now recognized as the global hotspot for globally endangered Ganges river dolphins, *Platanista gangetica* and Irrawaddy dolphins, *Orcaella brevirostris* and in response to that Government has now declared three sanctuaries for the dolphins in the off-shore areas south to the Sunderbans reserve forest (SRF). Also country's first MPA is now established in Swatch of No Ground area. Five marine fish species are found to be threatened, among them one is endangered *(Silonia silondia)*, and four are vulnerable (*Anguilla bengalensis, Plotosus canius, Carcharhinus limbatus* and *C. melanopterus*). Marine reptiles in Bangladesh such as snakes and turtles are found in St. Martin's Island, Sundarbans and the Bay of Bengal. Among 17 marine reptile species one is critically endangered (Hawksbill turtle- *Eretmochelys imbricate*) and four are endangered (Loggerhead turtle- *Caretta caretta,* Green tutrtle- *Chelonia mydas*, Olivegreen turtle- *Lepidochelys olivacea* and Leatherback turtle- *Dermochelys coriacea*). Three types of marine mammals are found in the Bay of Bengal, Bangladesh waters. Of these two are endangered (Blue whale- *Balaenoptera musculus* and Fin whale- *B. physalus*) and one is vulnerable (Humpback whale - *Megaptera novaeangliae*) (IUCN 2000).

The IUCN listed some species of the Sundarbans as threatened. Stock abundance of riverine catfish *Pangasius pangasius* in the SRF is very low and close to extinction. Another popular catfish *Plotosus canius* also at risk of extinction. The IUCN Red List designates 17% of assessed shark and ray species (of a total 1,045 assessed) to be threatened, 13% near threatened, 23% least concerned and 47% data deficient (Merry et al. 2007, Camhi et al. 2009). Current Red List of global assessments for BOB shark species are as follows:

Table 1. Red list status of shark species in the Bay of Bengal

Shark species	Scientific name	Red list status
Silvertip shark	*Carcharhinus albimarginatus*	Near Threatened
Bignose shark	*Carcharhinus altimus*	Data deficient
Spinner shark	*Carcharhinus brevipinna*	Near threatened
Silky shark*	*Carcharhinus falciformis*	Near threatened
Galapagos shark	*Carcharhinus galapagensis*	Near threatened
Blacktip shark*	*Carcharhinus limbatus*	Near threatened
Oceanic white tip shark	*Carcharhinus longimanus*	Vulnerable
Australian black tip shark	*Carcharhinus tilstoni*	Least concern
Tiger shark*	*Galeocerdo cuvier*	Near threatened
Blue shark	*Prionace glauca*	Near threatened
Whale shark*	*Rhincodon typus*	Vulnerable
Pelagic thresher shark	*Alopias pelagicus*	Vulnerable
Big eye thresher shark *	*Alopias superciliosus*	Vulnerable
Common thresher shark	*Alopias vulpinus*	Vulnerable
Crocodile shark	*Pseudocarcharias kamoharai*	Near threatened
Scalloped hammerhead shark*	*Sphyrna lewini*	Endangered
Great hammerhead shark *	*Sphyrna mokarran*	Endangered
Smooth hammerhead shark *	*Sphyrna zygaena*	Vulnerable
Spotted eagle ray*	*Aetobatus narinari*	Near threatened
Ornate eagle ray	*Aetomylaeus vespertilio*	Endangered
Manta ray	*Manta birostris*	Near threatened
Mobula ray	*Mobula tarapacana*	Data deficient
Smooth tail mobula	*Mobula thurstoni*	Near threatened

Source: Sattar and Anderson (2011); * also recorded from Bangladesh waters.

Policies, laws and legislations relating to conservation of biodiversity

A number of laws, regulations have been come into force in last four decades those are directly or indirectly addressing the issue of biodiversity conservation in Bangladesh. Bangladesh Environment Conservation Act 1995 is one that has clear mandate to conserve overall environment along with biological diversity and ecosystems. To deal with the three basic obligations of the Convention on Biological Diversity (CBD) viz., conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising out of uses of genetic resources, the institutional setup at the policy level is not main streamed and sensitized. Outdated bureaucracy is still very strong and playing a great hindrance for moving ahead towards knowledge-based conservation and management of biodiversity in Bangladesh. Overall, there is a lack of integration of environmental considerations in planning resulting in the absence for a truly integrated coastal management (ICM). Excessive climatic uncertainty, fishing and over exploitation of coastal resources, pollution, mangrove destruction, lack of public awareness and rampant rural poverty, institutional and legal limitations etc. are some of the major problems which need to be addressed on a priority basis.

ARTICLE-193 of UNCLOS confers upon member States the sovereign right to exploit their natural resources pursuant to their environmental policies and in accordance with their duty to protect and preserve the marine environment, which requires States to take all the measures consistent with UNCLOS to prevent, reduce and control pollution of the marine environment from any sources mentioned in this convention. Have we complied with this duty to protect marine environment and obligation to take measures to prevent and control the pollution of the Bay of Bengal coast? In the National Programme of Action 1999 under the Global Programme of Action of UNEP, twelve major issues,

such as industrial waste; sewage disposal; solid waste management; agro-chemicals; deforestation; salinity intrusion; urbanization; erosion; tourism; land use change and climate change, have been identified as the main sources of coastal and marine pollution in BoB. Approximately 1,800 tons of pesticides enter the Bay annually. It was reported that about 250 kg of polychlorinated biphenyl (PCB) are released from each ship in the ship breaking yard of Chittagong area. These toxic chemicals and pesticides are threats to both coastal and marine environment as well as public health (ICEAB 2010). If this pollution continues, it will certainly destroy important habitat and biodiversity; drive many wildlife species near to extinction; destroy mangrove forests; cause the whole ecosystem to become unbalanced and hinder sustainable development. For our survival and sustainable development, it is time to comply with the duty to protect marine environment and compliance existing laws and regulations to prevent, reduce and control pollution of marine environment. The Environment Conservation Act 1995 (amended 2010), followed by the Environment Conservation Rules of 1997, is the umbrella environmental legislation that provides for overall environmental conservation of the country.

ARTICLE-6 of CBD calls for an overarching framework for implementing the Convention through the development of National Biodiversity Strategy and Action Plans (NBSAP). With the development of NBSAP during 2003-2004, Bangladesh has made a big step forward fulfilling the global commitment of the country to the Convention on Biological Diversity. However, some biodiversity conservation activities, essentially complementary to NBSAP, have been initiated or implemented already, overlooking the document. In this context, it is clear that implementation of NBSAP has a long way to go. NBSAP has identified 16 strategies under which 128 actions programmes have been chalked out. Moreover, National Biodiversity Programme of Actions (BPA) 2020 built on nine focal areas, of which coastal and marine ecosystem pointed top priority. Focal areas defined as- Coastal and marine ecosystems conservation; Agro-ecosystem and agricultural biodiversity conservation; Wetlands ecosystems and fisheries biodiversity conservation; Hilly ecosystems and landscapes conservation; Forest biodiversity and conservation of wildlife; Biodiversity conservation in the face of climate change; Poverty reduction through fair and equitable sharing of benefits; Impact assessment and monitoring; Knowledge management, communication, education and public awareness etc. Under coastal and marine ecosystems conservation the following actions programmes have been identified:

Table 2. Study areas to be undertaken in National Biodiversity Programme of Actions 2020

Present status of coastal and marine biodiversity with taxonomic inventory and identifying hotspots, which are not under conservation schemes. Coastal afforestation along the embankments with suitable species. Co-management of marine fisheries ensuring sustainable use of fisheries resources. Conservation for globally threatened Irrawaddy dolphin by declaring coastal area off the Sundarbans as MPA.
Development of Guidelines/Regulations to ensure proper treatment and disposal of ballast water and sediments from marine ships in order to control IAS. Strategic environmental assessment of development activities and all potential interventions in marine areas.
Controlling land based pollution integrating industrial proponents and local government agencies.
Provisioning of the alternative livelihoods for the communities living surrounding Sunderbans. Updated study on the vegetation status and mapping of Sundarbans ecosystems. Declaring estuarine ECA in river Baleshwar and manage the area as estuarine sanctuary. Augmentation of rivers and creeks of the Sundarbans.
Establishment of national biodiversity geospatial database. Conservation of crocodiles in Brahmaputra and Madhumati floodplain.

Bangladesh's economic and ecological stability and flourishment is heavily dependent on maintaining its life supporting ecosystems and biodiversity thereof. In this context, biodiversity conservation should be the priority in the development agenda of the country. The BPA 2020 has been designed to address most of the burning conservation issues those once fully implemented may yield substantial difference in terms of establishing a prosperous nation with its enriched natural resource base. Government of Bangladesh should incorporate BPA 2020 into its development planning cycles. Any activity of BPA 2020 to be undertaken for implementation should undergo a consultative process that will involve not only scientists or policy makers but also the community peoples at the grass roots.

Conclusion and Recommendations

There is lack of awareness among the resource users about the interaction of various coastal components and they do not have enough knowledge about the resource and its importance, utilization and conservation. BPA 2020 is complementary to the implementation of Vision 2021 of the government to render the country as prosperous a nation.

A prosperous nation without having enough biological diversity is unimaginable. Therefore, the government policy and planning have to provide special attention on resource allocation for conservation and sustainable management of coastal and marine biodiversity.

- Accelerate the establishment of the national network of nature conservation and reserved, protected areas that include a full range, type and level of biodiversity and which will have a reasonable distribution and appropriate area coverage;
- Strengthen the research work to conserve the biodiversity of coastal and marine aquatic life for ex-situ conservation of endangered species of sea life forms;
- Measures to mitigate the adverse effects caused by pollution, cyclones and anticipated global warming and sea level rise;
- PES (Payments for Ecosystem Services) is positive incentives offered to people in exchange for specific behaviour or for ecosystem service outcomes. Hilsa fishery conservation has already been made towards a system of this kind.
- Promote the publicity and education on the protection of biodiversity. The promotional activities may be carried out through the use of various media.

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Domestic turtle trade: Barrier for freshwater turtle conservation

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Abstract

One hundred and four (104) village and wet markets in the southwestern, southern, eastern and central districts of the Bangladesh were surveyed between November 2009 and July 2010 to generate information on the status of freshwater turtles in domestic trade. In almost 60% of village markets traders were selling live freshwater turtles round the year that were captured and transported from all over the country and in some instances marine turtles (*Lepidochelys olivacea* and *Eretmochelys imbricata*) were also found. Among the thirty (30) odd species of turtles & tortoises known to occur in Bangladesh, twenty-three (23) are freshwater turtle species of which eighteen (18) species are threatened, some critically endangered. Only five (5) species (*Lissemys punctata, Panghsura tecta, Nilssonia hurum, Morenia petersi* and seldom *N. gangeticus* were regularly observed in the markets with rarely some odd species. It is high time that domestic trade be totally arrested. Capturing or trading turtles is not a primary source of livelihood. Transportation of turtles for trade is mostly by road or river crafts which can be monitored vigorously to cut the supply routes. Moreover the use of mobile phones in "home delivery" of live turtles and turtle meat is on the rise. Domestic turtle trade is doing more harm to the wild populations than some other factors like habitat destruction and pollution. This paper suggests that turtle species other than those which already are in the endangered category be also included in the endangered category. Granting these turtles endangered status would permit enforcement agencies to be more vigilant in monitoring domestic as well as international trade that threaten the survival of adults and natural recruitment. Seasonal ban particularly during the breeding season may also be an option. This is where participation and cooperation from every quarter is required to raise awareness and dealing strictly with violators. The task definitely is not easy but not impossible.

Introduction

The latest warnings related to species extinction are stark. Statistics demonstrate that the extinction rates of animal species are much higher than had been predicted only a few years ago. The worst affected - according to biodiversity experts - are freshwater species like fish, frogs, turtles and crocodiles. It is estimated that the freshwater species are becoming extinct six times faster than their terrestrial and marine cousins. Initiatives to come up with new goals to slow down the extinction rates are on the priority list of every country. The list of 100 endangered animals released by IUCN/SSC (at Jeju, IUCN World Congress 15th September, 2012) includes one turtle species (*Batagur baska*) found in Bangladesh.

Domestic turtle trade is on the cards for a very long time in Bangladesh. Ahamed (1958) listed some of the species consumed in Bangladesh (erstwhile East Pakistan). After the independence of Bangladesh there was an 'explosion' of exporting live turtles for human consumption from late 1970s in the magnitude of tens of tons every week till it was banned in 1998 (Rashid & Swingland 1990, 1997; Rashid & Khan 2000). During the 1980s and 1990s intensive and unregulated collection for commercial export in the tune of millions of dollars has virtually destroyed the viable natural populations of all the freshwater turtle species. Though the collection for commercial export of live turtles has been banned, the practice of collection has not changed but has decreased in magnitude. Yet domestic trade is still on-going jeopardizing the remnant populations of freshwater turtles. Occasional raids by the Forest Department and other law enforcement agencies and with the recent formation of the Wildlife Crime Control Unit have driven this illegal trade to continue clandestinely in urban areas whereas in the rural Bangladesh the trade goes unabated. In recent times with the sophistication in wireless communication technology much of the trade among the traders and regular customers is on the rise using mobile phones. In addition to the regular vigilance by the enforcement agencies cyber monitoring has also become a necessity to curb this illegal trade.

Table 1. Monetary figures of export earnings from export of live turtles. (Source: EPB 1998)

Year	Amount (BDT)	Year	Amount (BDT)
1974-75	1,000	1986-87	34,485,000
1975-76	17,000	1987-88	50,798,000
1976-77	1,187,000	1988-89	22,162,000
1977-78	5,520,000	1989-90	9,190,000
1978-79	6,914,000	1990-91	5,110,000
1979-80	12,948,000	1991-92	9,533,000
1980-81	16,326,000	1992-93	69,070,000
1981-82	22,506,000	1993-94	176,285,000
1982-83	22,884,000	1994-95	190,187,000
1983-84	24,251,000	1995-96	155,145,000
1984-85	23,247,000	1996-97	379,152,000
1985-86	41,135,000	1997-98	72,260,000

Further the conservation initiatives need to be further supported by current and reliable assessment information of the respective species and habitats/ecosystems that harbor those species. By generating data from market surveys the present status of the freshwater turtles may be ascertained. This was rationale behind this study.

Freshwater turtles, being a commodity of economic importance, offer opportunities to be linked up with livelihoods through alternative income generation activities like farming and captive breeding. Economic (=monetary) benefits may help develop a positive attitude towards conservation and support reintroduction to boost the declining freshwater turtle populations in the wild fulfilling the objective of conservation.

The numbers of collectors have reduced significantly since commercial export provided an opportunistic business and many people got involved in it. At present turtle trade is carried out by the people who were traditionally involved for several generations earning additional money from fishing. Interviews with the traders revealed that most of the traders belonged from Uzirpur, Barisal in the southwest region and they had connections with the traders in other parts of the country. Artisanal fishermen fishing in the Bay of Bengal also grabbed the opportunity to trade the marine turtles that got entangled in their nets and sold them to the traders who slaughtered them for human consumption.

Methodology

Field visits were made to the 104 village markets in the southwestern, southern and central districts of Bangladesh comprising the Chittagong, Khulna and Barisal divisions between November 2009 and July 2010. Prescribed data sheets (Annex I) were used to gather information based on direct observation in the markets and also information obtained from interviews of the traders. A list of the traders as well as village market calendar was prepared where turtles were traded. A species list, volume of trade for each species, trading methods and possible illegal routes were also determined.

Results

Among the 104 markets surveyed live turtles were traded in 61 markets (59%) of which live turtles were sold on a daily basis in 33 markets (54%) and in the remaining 28 markets (46%) traders brought in live turtles on the weekly market days. Sea turtles were found to be sold in 16 markets along with the freshwater turtles. All these turtles were collected from the wild from all over the country and transported mostly by road with few on boat or other means. Most of the communication was done by mobile phones for the supply and pricing. The network within the traders is very strong and secretive with mobile numbers changed frequently. Some of the traders/trade centers have permanent structures (tanks) and space to store the turtles as most of the turtles survive the cruelty shown to them after capture, during transportation and in housing them in abysmal and unhygienic condition.

Table 1. List of markets where traders sold freshwater and sea turtles (√-turtles traded, X- no turtles observed to be traded; Both- both freshwater and sea turtles).

Market Name		Market		Trading		
		Daily	Weekly	FW Turtles	Sea Turtles	Both
1	Jalmar Hat, Batiaghata, Khulna	-	√	√	-	-
2	Shukdarar Hat, Batiaghata, Khulna	-	√	X	x	x
3	Koiyer hat, Batiaghata, Khulna	√	-	√	-	-
4	Chashibunia, Batiaghata, Khulna	√	-	√	-	-
5	Shekhpura, Dacope, Khulna	-	√	X	X	X
6	Bazua/Khutakhali, Dacope, Khulna	-	√	-	-	√
7	Puddarganj, Dacope, Khulna	-	√	-	-	√
8	Kalinagar, Dacope, Khulna	-	√	-	-	√
9	Chalna Bazar, Dacope, Khulna	-	√	-	-	√
10	Baro Aria, Dacope, Khulna	-	√	X	X	X
11	Nalian, Dacope, Khulna	-	√	X	X	X
12	Betbunia, Dacope, Khulna	-	√	X	X	X
13	Lakhikhola, Dacope, Khulna	-	√	X	X	X
14	Laudube, Dacope, Khulna	-	√	X	X	X
15	Baniashanta, Dacope, Khulna	-	√	X	X	X
16	Kalabogi, Dacope, Khulna	-	√	X	X	X
17	Ramnagor, Dacope, Khulna	-	√	X	X	X
18	Sutarkhali, Dacope, Khulna	-	√	X	X	X
19	Digraj, Mongla, Bagerhat	-	√	-	-	√
20	Chila, Mongla, Bagerhat	-	√	-	-	√
21	Shelabunia, Mongla, Bagerhat	√	-	√	-	-
22	Boddomari, Mongla, Bagerhat	-	√	X	X	X
23	Bashtala, Mongla, Bagerhat	-	√	X	X	X
24	Joymoni, Mongla, Bagerhat	-	√	X	X	X
25	Kolabaria/Katakhali, Mongla, Bagerhat	-	√	X	X	X
26	Gona Bridge, Mongla, Bagerhat	-	√	-	-	√
27	Foyla, Rampal, Bagerhat	-	√	√	-	-
28	Vharoshapur, Rampal, Bagerhat	-	√	√	-	-
29	Perikhali, Rampal, Bagerhat	-	√	X	X	X
30	Janjonia, Rampal, Bagerhat	-	√	X	X	X
31	Gauramvha, Rampal, Bagerhat	-	√	X	X	X
32	Gilatala, Rampal, Bagerhat	-	√	X	X	X
33	Perikhali, Rampal, Bagerhat	-	√	X	X	X
34	Chulkati, Rampal, Bagerhat	-	√	X	X	X

Market Name		Market		Trading		
		Daily	Weekly	FW Turtles	Sea Turtles	Both
35	Bagar hat, Rampal, Bagerhat	-	√	√	-	-
36	Kalkalia, Fakirhat, Bagerhat	-	√	X	X	X
37	Mulghar , Fakirhat, Bagerhat	-	√	X	X	X
38	Betaga, Fakirhat, Bagerhat	-	√	X	X	X
39	Chulkati, Fakirhat, Bagerhat	-	√	X	X	X
40	Fakirhat, Fakirhat, Bagerhat	-	√	X	X	X
41	Battala, Fakirhat, Bagerhat	√	-	√	-	-
42	Chitolmari, Mollarhat, Bagerhat	-	√	√	-	-
43	Bakhorganj, Mollarhat, Bagerhat	-	√	X	X	X
44	Khaserhat, Mollarhat, Bagerhat	-	√	X	X	X
45	Babugonj, Mollarhat, Bagerhat	-	√	X	X	X
46	Naluar hat, Mollarhat, Bagerhat	-	√	X	X	X
47	BaroBaria, Mollarhat, Bagerhat	-	√	X	X	X
48	Faltita, Mollarhat, Bagerhat	√		√	-	-
49	Shekpura, Terokhada, Khulna	-	√	X	X	X
50	Majirgati, Dogolia, Khulna	√	-	√	-	-
51	Shiali, Rupsha, Khulna	-	√	-	-	-
52	Rupsha, Khulna City Corporation	√	-	√	-	-
53	Shitalabari, Khulna City Corporation	√	-	√	-	-
54	Badal, Bagerhat, Bagerhat	-	√	X	X	X
55	Parer Hat, Pirojpur, Bagerhat	-	√	√	-	-
56	Matbaria, Pirojpur, Bagerhat	-	√	√	-	-
57	ShikdarMollik, Pirojpur, Bagerhat	-	√	√	-	-
58	ShihaShatpar, Gopalganj, Gopalganj	-	√	√	-	-
59	Tekerhat Bus Stand, Gopalganj, Gopalganj	-	√	√	-	-
60	Gaendershur, Gopalganj, Gopalganj	√	-	√	-	-
61	Baiar Char/Jolirpar, Gopalganj, Gopalganj	√	-	√	-	-
62	Patgati, Tongipara, Gopalganj	-	√	√	-	-
63	Taral, Tongipara, Gopalganj	-	√	√	-	-
64	Khuslir hat, Tongipara, Gopalganj	-	√	√	-	-
65	Dumuria, Shayamnagar, Satkhira	-	√	X	X	X
66	Chandimukha, Shayamnagar, Satkhira	-	√	-	-	√
67	Gabura, Shayamnagar, Satkhira	-	√	X	X	X
68	Noabeki, Shayamnagar, Satkhira	-	√	X	X	X
69	Autulia Bridge, Shayamnagar, Satkhira	-	√	X	X	X

Market Name		Market		Trading		
		Daily	Weekly	FW Turtles	Sea Turtles	Both
70	Nildumur, Shayamnagar, Satkhira	-	√	X	X	X
71	Munshiganj, Shayamnagar, Satkhira	-	√	-	-	√
72	Harinagor , Shayamnagar, Satkhira	-	√	-	-	√
73	Munshiganj Garage, Shayamnagar, Satkhira	-	√	-	-	√
74	Sundarban School, Shayamnagar, Satkhira	-	√	X	X	X
75	Bhetkhali, Shayamnagar, Satkhira	-	√	-	-	√
76	BongshipurMor, Shayamnagar, Satkhira	-	√	-	-	√
77	ShonarMor, Shayamnagar, Satkhira	√	-	-	-	√
78	Jhapa, Shayamnagar, Satkhira	-	√	X	X	X
79	Paranpur, Shayamnagar, Satkhira	-	√	X	X	X
80	ShyamnagarUpazilla, Shayamnagar, Satkhira	-	√	X	X	X
81	Patuakhali launch ghat, Patuakhali, Patuakhali	√	-	√	-	-
82	Galachipa, Patuakhali, Patuakhali	√	-	√	-	-
83	Kalaiar Bazar, Patuakhali, Patuakhali	√	-	√	-	-
84	Kalapara, Patuakhali, Patuakhali	√	-	√	-	-
85	Pakhimara, Patuakhali, Patuakhali	√	-	√	-	-
86	Jhalokatipiazpotti, Jhalokathi, Jhalokathi	√	-	√	-	-
87	Barisal Mach Bazar, Barisal, Barisal	√	-	-	-	√
88	Barisal Natun Mach Bazar, Barisal, Barisal	√	-	√	-	-
89	Goila, Barisal, Barisal	√	-	√	-	-
90	Barguna Mach bazaar, Barguna	√	-	√	-	-
91	Kalinath Bazar/ Turtle Trading Centre, Bhola	√	-	-	-	√
92	Guptoshumi, Paranganj, Bhola	√	-	√	-	-
93	Charfesson, Bhola	√	-	√	-	-
94	Lalmohon, Bhola	√	-	√	-	-
95	Illisha Bus Stand, Bhola	√	-	√	-	-
96	Faridpur Mach Bazaar, Faridpur	√	-	√	-	-
97	Vanga Turtle Trading Centre, Faridpur	√	-	√	-	-
98	Amgram, Razore, Madaripur	√	-	√	-	-
99	Feni Turtle Trading Centre, Feni	√	-	√	-	-
100	Comilla Mach Bazaar, Comilla	√	-	√	-	-
101	Noakhali Mach Bazaar, Maizdi, Noakhali	√	-	√	-	-
102	Shakharipatti, Dhaka	-	√	√	-	-
103	Tanti Bazaar, Dhaka	-	√	√	-	-
104	Farm Gate, Dhaka	√	-	√	-	-
	TOTAL	**33**	**71**	**45**	**0**	**16**

Table 2. Species commonly observed to be traded in the markets with some occasional rarities

Species Observed in All Markets		Occasional Species/Rarities	
Flapshell turtle	Lissemyspunctata	Gangetic Softshell	*Nilssonia gangeticus*
Peacock Softshell	Nilssoniahurum	Black Softshell Turtle	*Nilssonia nigricans*
Roofed Turtle	Pangshura tecta	Southeast Asian Softshell Turtle	*Amyda cartilaginea*
Bengal Eyed Turtle	Moreniapetersi	Frog-faced Softshell Turtle	*Pelochelys cantorii*
		Northern River Terrapin	*Batagur baska*
		Crowned River Turtle	*Hardella thurjii*
		Black Spotted Turtle	*Geochemys hamiltonii*
		Southeast Asian Box Turtle	*Cuoraam bionensis*
		Leaf Turtle	*Cyclemys dentata*
		Tent Turtle	*Pungshura tentoria*
		Elongated Tortoise	*Indotestudoe longata*
		Olive Ridley Turtle	*Lepidochelys olivacea*
		Hawksbill Turtle	*Eretmochelys imbricata*

The four species mentioned above (Table 2) are the ones found in all the markets surveyed selling live turtles. The occasional or rare species were recorded once in a while. For example, only one specimen of P. cantorii was observed with the trader in Barisal. Another trader in Bhola reported about Chitraindica but was not observed and not listed in Table 2. However it was known to be sold once in a while. A trader in Gaendershur, Gopalganj slaughtered a Hawksbill Turtle and a *B. baska* brought from the Sundarban Reserve Forest; a trader in Feni had Elongated Tortoise and *Cyclemys dentata*, while another one had *C. ambionensis*. This suggested that turtle collectors were also involved in the hill districts.

A contact list of about one hundred traders has been prepared who were involved in trade. In some cases a single trader sold turtles in several markets depending on the weekly market days. Each trader maintained links with several collectors and 'mahajans' (businessmen, who often lend money). Some 'mahajans' also keep a team of collectors who visit different areas to either hunt or buy turtles from other collectors. Fig. 1 illustrates the links between the different stakeholders in the turtle trade.

Turtles collected anywhere in Bangladesh reach the traders through their widespread but clandestine network and are transported live. The survey also showed that due to lack of supply of freshwater turtles to meet the local demand, sea turtles were started to be consumed, as well.

Turtle collection consists of several stages – collectors/hunters (shikari), middlemen/supplier (mahajan), turtle/fish depot owners (whole sellers, aaratdar), supplier/retailer, local retailers and consumers. Often the same people play different roles in this trade chain. Collection is carried out all over Bangladesh and brought to the trading centers located in various locations of the country particularly the southern districts of Bangladesh.

The market however is controlled by businessmen who were involved with commercial export as suppliers or middleman. The trade network of suppliers is mostly confined within the people of the same clan or group and in extreme confidentiality. Turtles fetch money – people have known this very well. So every single turtle that is found is collected and sold for consumption. Sea turtles have also become a commodity to supplement the domestic trade. Domestic trade is putting the last pegs to the freshwater turtle's coffin in Bangladesh.

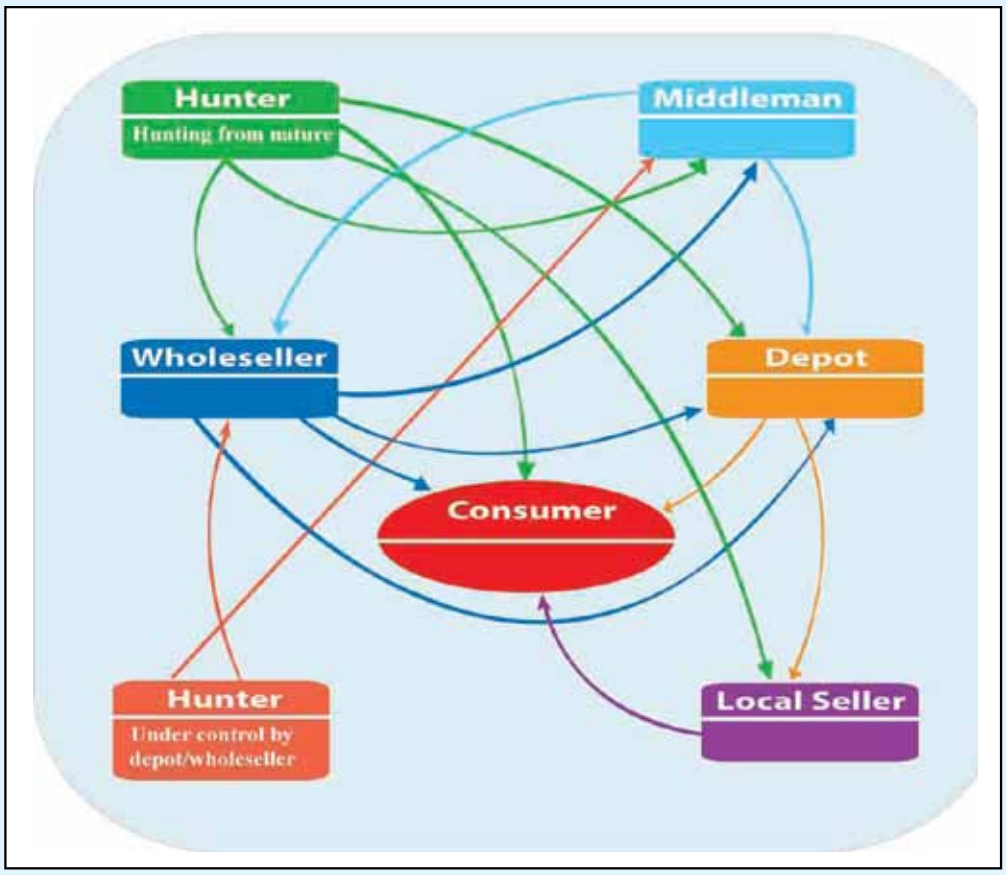

Fig. 1. Illustration showing the links between the different stakeholders in the turtle trade.

This suggests that the diversity of the natural populations of freshwater turtles is primarily affected due to unregulated capture from the nature in addition to other factors of habitat destruction, land use change, and pollution. International export of live turtles is banned but the soft cartilage of the soft-shelled turtles is dried and exported labeled as dry fish to Far Eastern countries. Bangladesh also plays the role of transit for the illegal shipments of soft-shell turtle cartilage from India.

Many of the species involved in trade are endangered. By conducting some intensive surveys and monitoring the status of the turtles may be estimated. However it is high time that the domestic trade be dealt with iron hand to save the wild populations. Among the 30 odd species that Bangladesh boasts to have within her territory 23 species are freshwater. Apart from the four common species the remaining are all threatened. Unregulated trade will also threaten the four common species. The on-going exercise of ascertaining the present status of species by IUCN provides an opportunity to grant these species the endangered status which may assist in putting the freshwater turtle species under critical surveillance by raising the species profile.

Turtle identification has been a problem with the law enforcing personnel and wildlife staff of the Forest Department. Targeted trainings designed for the relevant personnel will increase their capacity in enforcement and regulating domestic trade as well as to confiscate any illegal international/domestic shipment. Awareness materials in local language on the plight of the turtles and their habitat and the need to protect and conserve them will be produced for mass distribution. Religious leaders of the communities who are the major consumers may play a vital role to deter the community members from consuming the turtles.

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Use of the media to characterize recent trends in human-wildlife conflict in Bangladesh: 1990-2010

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Abstract

Bangladesh has converted extensive areas including tropical forest for agriculture, those were crucial habitats for many species. As a result human-wildlife conflict has increased in many parts of the country, and will likely continue to do so if deforestation and forest degradation show no sign of abating. Little is known however about the extent of human-wildlife in around Bangladesh, the number and diversity of taxa that engage in conflicts, and the conflict trend in the country through time. This study reviewed anecdotal media-reported accounts of human-wildlife conflict over the past two decades in Bangladesh. These accounts, reported in major daily newspapers based in Dhaka, were reviewed at five year intervals over the 20 year span between 1990-2010. We documented a total of 422 human-wildlife conflict incidents that involved 89 different species. We determined that trends in the frequency of conflict as reported by media increased significantly over this 20 year period and were highest in 2010. A total of 8.89% of all native species were reported as engaging in some conflict-related activities. Though birds represented the greatest taxonomic diversity of all species involved (56.18%), mammals were subject of the greatest number of total conflict incidents (63.74%). Bengal Tigers were the most often reported conflict species (19.43%) and were reported every year. Asian Elephant (13.51%), birds of many species (14.45%), and snakes often reported moderately (17.06%) were also reported in some conflict-related incident every year. Lack of an effective infrastructure for addressing conflict-related issues involving wildlife represents an immediate obstacle to mitigation, particularly in rural areas. We believe that to quickly and efficiently address these issues nationwide, it is imperative that various departments of national and local governments, conservation NGO's, and local community leaders should work cooperatively, share expertise, and provide supporting resources to those experiencing conflict problems.

Key words: *Anecdotal Reports, Bangladesh, Human-Wildlife Conflict, Human Dimensions, Tiger, Elephant, Mammals, Snakes*

Introduction

Human-wildlife conflict is a common and growing phenomenon in both rural and urban areas around the world (Wang and Macdonald, 2005). We define human-wildlife conflict here as any incident involving wildlife whereby the activities of that wildlife negatively impact the resources of a given human population, including posing direct threats to humans themselves. Such conflict could then lead to retribution against or local persecution of these wildlife species. For the purposes of this study, our definition also follows Muhammed et al. 2007, which includes all human-caused mortalities of wild animals, such as subsistence poaching, or commercial trade in wildlife parts, as this study documents the occurrence of these types of activities for migratory birds.

Human-wildlife conflict often arises when species consume or otherwise use a common but limited resource; such resources can broadly include but are not limited to land, crops, livestock, and even cultivated fish (Graham et al. 2005; Schwerdtner and Bernd 2007).Crop raiding, property damage, livestock depredation, and conflict involving human casualties are among the most common and/or serious forms of conflict with wildlife around the world (Ogra and Badola, 2008; Inskip and Zimermann, 2009).

Bangladesh has an area of approximately 147,570 km^2 with a very high human population growth. Though small, the

country's biodiversity is incredibly diverse; among its native species are 121 species of mammals, 690 species of birds, 154 species of reptiles, and 36 known species of amphibians (Khan, 2008; Feeroz et al., 2011). As human population continues to increase in Bangladesh, people will invariably conflict more with wildlife as available resources and space decline. The establishment of new settlements via rapid urbanization and industrialization, expanding agricultural and aquacultural interests and various developmental programs, is now among the ultimate causes of conflict. The Sundarbans for example hosts some of the greatest intensity and frequency of conflict between tigers (*Panthera tigris tigris*) and humans in the world (Siddiqui and Choudhury, 1987; Chakrabarti, 1992). Altogether approximately 350,000 people collect forest products from the Sundarbans annually, thus exposing themselves to direct predation by and conflict with tigers (Barlow et al., 2009; Gain, 2002). Asian elephants (*Elephas maximus*) have become incompatible neighbors with rural farmers and the poor in many parts of the species already-limited national range (Sarker & Rocket, 2010). Our objective here was to broadly categorize the frequency and level of human-wildlife conflict occurring in Bangladesh from 1990-2010.

Methods

Daily newspapers in Bangladesh regularly publish both brief and occasionally more extensive accounts of human-wildlife conflict occurring around the country. We reviewed three most popular newspapers in Bangladesh i.e., the daily Prothom Alo (Bangla), the daily Ittefaq (Bangla) and the Daily Star (English), at five year intervals between 1990-2010. In other words, we reviewed all published accounts of human-wildlife conflict in all three newspapers in 1990, 1995, 2000, 2005 and 2010. In particular, we were most interested in assessing how the following quantities varied through time: (1) the total number of conflict-related incidents for each of the five years, (2); total tallies for all species involved in conflict incidents, (3) total number of people either killed or injured across all conflict incidents, (4) the total number of wildlife killed and/or injured during conflicts, and (5) the total number of wildlife rescued. To assess significance difference between nominal variables, we used a simple chi-square (2) test of observed and expected values (significance = $p < 0.05$).

Results and Discussion

Trends in the frequency of human-wildlife conflict

We recorded a total of 422 conflict-related incidents for all taxa as reported in the three major newspapers we reviewed for each of the 5 years chosen over the two decade span. The total number of human-wildlife incidents reported increased gradually but significantly between 1990 and 2010 (χ^2=170.2, df=4, α=0.05) as measured by the annual frequency of reports in papers for each of our five-year intervals. Almost half of all incidents reported overall (43.36%, n=183) occurred in 2010 (Table 1). Humans reportedly killed during conflict varied over all years reviewed (χ^2=22.7, df=4, α=0.05) but increased overall in the frequency of incidents. The most people killed during conflict incidents were in 2010 (30.77%, n=60), significantly more than in any of previous years ($p<0.05$); in 2005, people were injured non-lethally significantly more than in 1990, 1995, 2000, and 2010 (40.13%, n=128; $p<0.05$). Moreover, some kind of injury to a human was significantly more likely than not for all human-wildlife conflict incidents (χ^2=194.8, df=4, α=0.05). Although killing of wildlife varied among the five years where media accounts were reviewed, the number of lethal retributions during or following conflict episodes varied significantly (χ^2=2081.2, df=4, α=0.05) and trended exponentially upwards over the 20- year period, culminating in 2010 (75.88%, n=796; Table 1). However, two decades prior (i.e., 1990) there are few reported accounts of wildlife being killed by people in these same newspapers (0.29%, n=3). Wildlife injury also varied (increased) significantly across the 5- year intervals we examined reports (χ^2=19.4, df=4, α=0.05). Interestingly and in direct contrast to these aforementioned trends, nonlethal remedies such as translocation and placing the animal in captivity, were significantly greater in more recent years than in earlier years (χ^2=11879.5, df=4, α=0.05).

Trends in species engaged in human-wildlife conflict

We identified a total of 89 species reportedly involved in conflict with humans over a 20- year period (Table 2). Moreover, while in 1990 only 10 species were reported by the media as being involved in conflict, by 2010 there were 78, significantly more than any prior year (χ^2=329.7, df=4, α=0.05) (Fig. 1). In fact of all native wildlife recorded for Bangladesh (n=1001), 8.89% species of that total was reported as involved in some form of conflict. Those mammals involved in conflict represented 19.83% of all known native mammals, a larger proportion than any other taxonomic group (birds involved in conflict: 7.25% of all known birds; reptiles involved in conflict: 8.44% of all known reptiles; amphibians involved in conflict: 5.56% of all known amphibians).

Birds were the taxonomic group with the greatest number of species involved in conflict (56.18%, n=50); however, mammals were involved in nearly twice as many conflict incidents (63.74%, n=269) overall than birds, reptiles, and amphibians combined (Fig. 2). Moreover, the number of mammal species (χ^2=95.6, DF=5, α=0.05), bird species (χ^2=76.95, DF=5, α=0.05), reptile species (χ^2=47.8, DF=5, α=0.05), and amphibian species (χ^2=15.7, DF=5, α=0.05)

varied significantly among each 5-years interval. From 1990-2010, the number of mammals, birds, and reptiles reported in conflicts increased from 6 to 20 species, 2 to 46 species, and 1 to 12 species respectively (Table 2).

Over the past twenty years, more conflicts were reported for the Bengal Tiger (19.43%, n=82) than any other species. This was followed by snakes of all species combined, which were not always identified (17.06%, n=72); birds of all species (14.45%, n=61); and the Asian Elephant (13.51%, n=57). Furthermore, all of these taxa were reported as conflict-involved in all five years over the 20-year period. Leopards (*Panthera pardus*; 1.66%) and three deer species (*Muntiacus muntjak*, Axis, *Cervus unicolor*; 7.11%) were reported all years except in 1995. Additional species exhibiting relatively high numbers of conflict include the fishing cat (*Prionailurus viverrinus*; 4.50%), bandicoot rats (*Bandicota* sp.; 2.84%), Ganges river dolphin (*Platanista gangetica*; 2.61%), and jackal (*Canis aureus*; 2.61%).

Overview of special cases

Human-Tiger Conflict

Conflict between human and tiger has a long history in the Bangladesh Sundarbans (Blanford, 1891). People are most frequently attacked when they foray into the forest for various natural products, or conversely when tigers enter into villages to kill livestock (Barlow et al.2009). In the Sundarbans, the number of conflict reports involving Bengal tigers varied significantly across five-year intervals (χ^2=34.2, df=5, α=0.05), as did the number of tiger-caused human mortalities (χ^2=25.1, df=5, α=0.05) and injuries (χ^2=9.9, df=5, α=0.05). The greatest number of reported tiger-conflict incidents (45%) and those where human casualties accompanied the conflict (39%) occurred during 2010 (Table 3). Of the 5 years we sampled newspapers between 1990-2010, the number of tigers killed by humans (n=10) varied significantly (χ^2=12.0, df=5, α=0.05); most however were killed (n=6) in 2000.

Human-Snake Conflict

Venomous snakes pose a direct danger to people, as many native species can deliver a fatal bite. They are also themselves often immediately beaten to death when they enter into the human habitations searching for food. Non-venomous snakes, often not distinguished from dangerous ones by local people, also often suffer the same fate. The greatest number of reported conflict incidents involving snakes (46%) appeared to occur in 2000, along with the highest proportion of all human snakebite fatalities (53%). In contrast, a greater proportion of conflict incidents where snakes were both killed (66%) and rescued (92%) occurred during 2010. The number of reported conflict incidents involving snakes (χ^2=44.8, df=5, α=0.05), as well as those involving both human (χ^2=39.3, df=5, α=0.05) and snake casualties (χ^2=372.7, df=5, α=0.05), varied across all five years over the 20-year period.

Human-Bird Conflict

From 1990-2010 at five-year intervals, the number of bird species engaged in conflict varied significantly (χ^2=76.95, df=5, α=0.05). Most incidents occurred in 2010 (64%), including reports where birds were both killed (97%) and rescued (99.92%). Migratory birds visit Bangladesh annually every winter for both feeding and breeding purposes; many of these species are anticipated and so are hunted illegally. Of the bird species we report on here, 20% (n=10 species) are among those migratory birds reported as killed, while a great diversity of resident species (76% of conflict birds; n=37 species) are also illegally hunted.

Human-Elephant Conflict

Over the past 30 years, conflicts between people and elephants have intensified and become a crucial conservation issue (Nelson et al. 2003). Human-elephant conflict is usually a direct result of rapid and expansive changes to the landscape, such as for agriculture and other anthropogenic uses (Nelson et al., 2003, Sarker and Røskaft, 2010). The greatest total number of human-elephant conflict incidents (28%), as well as incidents involving human casualties (31%), were reported for 2005 and 2010 respectively (Table 3). Humans were injured significantly (χ^2=40.5, df=5, α=0.05) during human-elephant conflict. Only 3 elephants were reported killed over the five years of papers reviewed from 1990-2010; however, 2 of these occurred in 2005.

Conclusion

As urbanization increases and the human population continue to grow, incidents of human-wildlife conflict are increasing around the world and expanding to new areas. In Bangladesh, our results imply that all types of human-wildlife conflict appear to have increased in frequency over past two decades. As competition for limited resources increases, and injuries or fatalities to both people and wildlife, damage to human property, and loss of livestock and other agricultural resources, all continue to rise, it is logical to assume attitudes toward many species will become increasingly negative, perhaps even hostile. This only compounds the challenges of effectively implementing conservation programs for any of

these species, particularly the most threatened. As it stands now, most rural citizens of Bangladesh are generally ignorant of wildlife conservation issues, as well as basic ecological relationships. Public awareness and outreach however may be effective in changing people's attitudes, as would a cooperative, inter-departmental governmental program designed to reduce human-wildlife conflict in hotspot areas. Better enforcement of wildlife protection laws, and greater presence of conservation non-governmental organizations, should also be part of a holistic strategy to effectively address human-wildlife conflict.

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Table1. Trends of human-wildlife conflict in Bangladesh from 1990-2010.

Year	TI (n=422)	HK (n=195)	HI (n=319)	WK (n=1049)	WI (n=7)	WR (n=3245)
2010	43.36	30.77	36.36	75.88	85.71	96.52
2005	19.91	11.79	40.13	10.30	14.29	1.39
2000	18.96	24.62	15.99	9.25	0	2.03
1995	6.40	15.38	5.33	4.29	0	0.03
1990	11.37	17.44	2.19	0.29	0	0.03

TI= Total Incident, HK= Human Killed, HI= Human Injured, WK= Wildlife Killed, WI= Wildlife Injured, WR= Wildlife Rescued (i.e, wildlife was taken into captivity or translocated elsewhere).

Table 2. Taxa associated in conflict at each five-year interval.

Wildlife	**Years**	**Number of Conflict Species**	**Number of Incidents**
Mammals	2010	20	112
	2005	14	62
	2000	8	40
	1995	4	20
	1990	6	35
	Total	**24***	**269**
Birds	2010	46	39
	2005	12	10
	2000	4	6
	1995	1	1
	1990	2	5
	Total	**50***	**61**
Reptiles	2010	12	32
	2005	6	12
	2000	1	33
	1995	2	6
	1990	1	3
	Total	13*	86
Amphibians	2010	0	0
	2005	0	0
	2000	1	1
	1995	0	0
	1990	1	5
	Total	**2**	**6**

* = Some species were involved in conflict each of the five years but were counted only once.

Table 3. Percentage of various attributes associated with human-wildlife conflict by taxa.

Wildlife	Years	TI	HK	HI	WK	WI	WR
Tiger	2010	45	39	22	20	100	0
	2005	17	11	28	0	0	0
	2000	17	15	34	60	0	100
	1995	10	10	3	0	0	0
	1990	11	25	13	20	0	0
Snakes	2010	31	18	100	66	0	92
	2005	11	7	0	1	0	5
	2000	46	53	0	16	0	2
	1995	8	15	0	18	0	1
	1990	4	7	0	0	0	0
Birds	2010	64	0	0	97	0	99.92
	2005	16	0	0	0	0	0.04
	2000	10	0	0	3	0	0.04
	1995	2	0	0	*	0	0
	1990	8	0	0	*	0	0
Elephants	2010	21	31	8	33	0	0
	2005	28	18	28	67	100	100
	2000	19	12	42	0	0	0
	1995	16	14	0	0	0	0
	1990	16	24	22	0	0	0

Key: TI= Total Incident, HK= Human Killed, HI= Human Injured, WK= Wildlife Killed, WI= Wildlife Injured, WR= Wildlife Rescued, *= Specific number was not found.

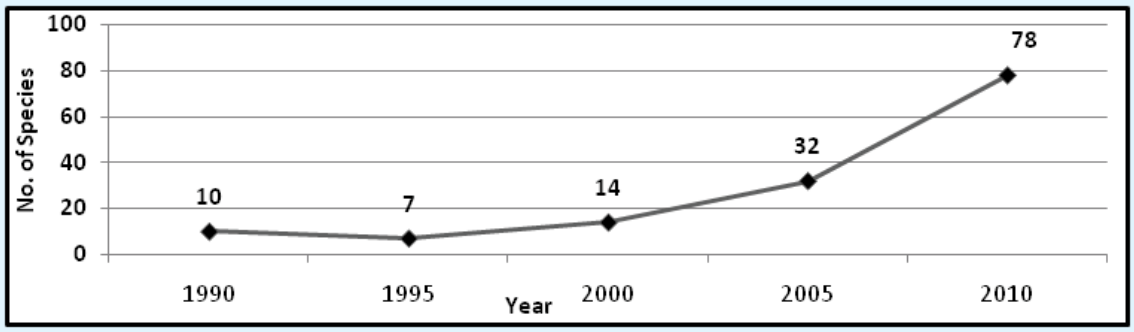

Figure 1. Trends in the number of species involved in human-wildlife conflict over the past two decades.

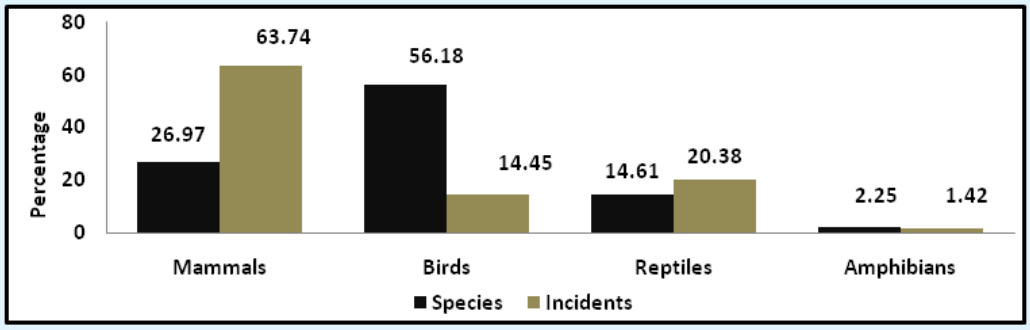

Figure 2. Cumulative taxonomic representation of wildlife and the percentage of incidents they were involved in for all accounts of conflict evaluated (1990, 1995, 2000, 2005, and 2010).

Birds of five protected areas of Bangladesh and temporal changes in the densities of indicator species

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Abstract

The birds of five protected areas (Lawachara, Satchari, Rema-Kalenga, Chunati and Teknaf), situated in the north-east and south-east of Bangladesh, were studied during 2005–2008 by strip transect sampling and opportunistic surveys. A total of 239 species of birds was recorded in five protected areas, of which 189 were residents, 39 winter visitors, 6 summer visitors and 5 vagrants. The relative abundance shows that a total of 40 (17%) species were 'Very Common', 66 (28%) 'Common', 48 (20%) 'Fairly Common' and 85 (35%) 'Few'. The population densities of eight species of bird, that were selected as indicators, were estimated and it was found that two species, Red Jungle fowl *Gallus gallus* and Puff-throated Babbler *Pellorneum ruficeps*, which live in the under storey of the forest, have increased over the last four years. This might be an indication of the regeneration of forest under storey, increasing the carrying capacity and nesting sites for these two species, and reduction of hunting pressure. However, the illegal logging of timber trees is still going on in some areas, which is probably causing the decline of one indicator species, Oriental Pied Hornbill *Anthracoceros albirostris*. The densities of the other five indicator species (Red-headed Trogon *Harpactes erythrocephalus*, Greater Racket-tailed Drongo *Dicrurus paradiseus*, White-rumped Shama *Copsychus malabaricus*, Hill Myna *Gracula religiosa* and White-crested Laughing thrush *Garrulax leucolophus*) remained more or less unchanged over the four years.

Introduction

Bangladesh has a network of protected areas under the jurisdiction of the Forest Department, but little information is available on the birds of these areas. Moreover, there had been no attempt to use birds as indicators of the ecological change in the protected areas. Birds are one of the best indicators of ecological change (Johnston 1956, Morrison 1986, Welsh 1987, Temple & Wiens 1989, Browder et al. 2002). Different species of bird occur in different vertical strata of an area and are adapted to specific types of plant and animal food. Therefore, avian population density and species diversity reflect the temporal changes of their habitat conditions, and consequently birds indicate the health of different vertical strata of the forest. Determination of the extent to which ecological systems are experiencing change is critical for the long-term conservation of biotic diversity (Canterbury et al. 2000).

Bangladesh is exceptionally rich in bird diversity and abundance. In an area of only 147,570 km^2, Bangladesh harbours nearly 700 species of bird, which is 50% of the total of the Indian Subcontinent, and 7% of the world's total (Harvey 1990, Khan 2008). However, the natural forests and other wilderness areas of the country are under great pressure from legal and illegal over exploitation, together with improper management. It is estimated that forest cover has been reduced by more than 50% since the 1970s (IUCN-Bangladesh 2000). Bangladesh has less than 0.02 ha of forest land per person—one of the lowest forest-to-population ratios in the world (IUCN-Bangladesh 2000). The urgent need to conserve the remaining natural forests and their inhabitants, while developing non-consumptive uses of the forests at the same time, gave rise to the Nishorgo Support Project (NSP), a five-year project of the Forest Department that was implemented by the International Resources Group (IRG) of Washington DC, together with its local partners.

The work reported here was supported by NSP, which used the results as a tool to understand the impact of newly introduced co-management on five protected areas. In our survey, the temporal changes of population densities of eight indicator species of bird were studied so that the ecological health of five protected areas could better be monitored. Observations of all species of birds were recorded, together with their relative abundance. The study was conducted on a participatory basis, involving birdwatchers, local communities and Forest Department officials in order that everybody would become aware of what is happening to the birds in these sites.

There are 28 protected areas in Bangladesh with a total area of 8,718.87 km^2, covering only 5.9% of the total area of Bangladesh. All the five protected areas (Lawachara, Satchari, Rema-Kalenga, Chunati and Teknaf; Fig. 1, Table 1) where the bird survey was conducted are mainly covered by mixed evergreen forests, but the areas also have some bushy and bamboo-covered areas.

Methods

The survey methods were selected on the basis of simplicity and effectiveness so that the local stakeholders, including local people with little or no education, could participate on their own. Strip transects sampling (Buckland et al. 2001) and opportunistic survey methods were selected. It was decided that the survey would be conducted in the breeding season (February–August), so that there would be more bird activity. The baseline survey was conducted in 2005, and was repeated in 2006, 2007 and 2008, in the same season and following the same transects so that the results could be compared across different years.

Strip transect sampling was found most suitable to estimate the population densities of eight indicator species of bird (see below for how and why the indicator species were chosen). In this method the observers slowly walked (c.1.5 km/hr) on relatively straight lines through the study areas and counted the indicator birds from both sides. The observation-range on each side (half-width of the strip) was 20 m, which was found suitable in terms of visibility. Therefore, the strip width was 40 m. The initial location of the bird was recorded while counting, because it often moves away after watching the observer(s). The observation-range was measured by an infrared range finder (Bushnell Yardage Pro). If any bird was sighted beyond the pre-decided observation-range, or if the bird was seen coming from the back where the counting had already been done the bird was not counted. The survey was conducted in early mornings and late afternoons when the birds were most active. This method assumes that all birds in the strip are recorded. Transects were located mainly in the rich parts of the protected areas. Depending on the sizes of the protected areas, the total lengths of transects in each site varied from 3.00 to 6.96 km (Table 1), but transects were periodically repeated for 12–15 times per year.

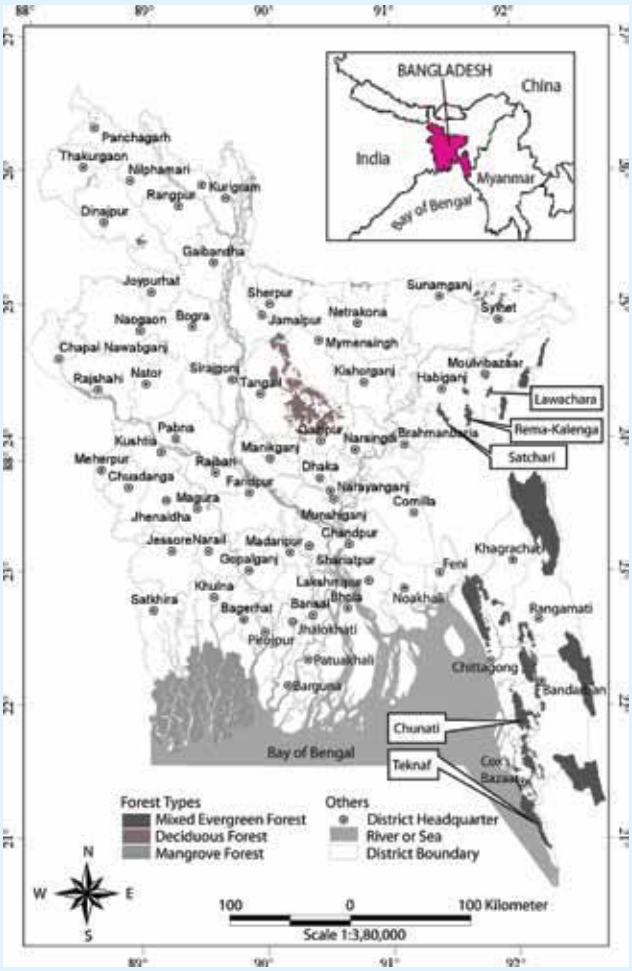

Figure 1. Forested areas of Bangladesh showing the locations of five NSP sites where the survey was conducted.

The eight indicator species of bird, which were suggested at a meeting of bird experts, organised in IRG, Dhaka, are: Red Jungle fowl *Gallus gallus*, Oriental Pied Hornbill *Anthracoceros albirostris*, Red-headed Trogon *Harpactes erythrocephalus*, Greater Racket-tailed Drongo *Dicrurus paradiseus*, White-rumped Shama *Copsychus malabaricus*, Hill Myna *Gracula religiosa*, White-crested Laughing thrush *Garrulax leucolophus* and Puff-throated Babbler *Pellorneum ruficeps*. They were selected because: (1) they are primarily forest birds, (2) they live in different vertical strata of the forest (Red Jungle fowl, White-crested Laughing thrush and Puff-throated Babbler in lower stratum; Red-headed Trogon, Greater Racket-tailed Drongo and White-rumped Shama in middle stratum; and Oriental Pied Hornbill and Hill Myna in upper stratum), (3) they are noisy (and thus less likely to be missed during counts), and (4) they are breeding residents. Since all the indicator species are primarily forest-dwellers, it was assumed that the improvement or degradation of the forest condition would have a direct impact on the feeding and breeding of the indicator species, which in turn would show changes in population densities (Morrison 1986, Temple & Wiens 1989, Canterbury et al. 2000, Browder et al. 2002, Lammertink et al. 2009).

Table 1. Strip transect locations in five NSP sites where the bird survey was conducted

Name of Project Site	Transect Location in Project Site	Geographic Locations of Two Ends of Transect	Transect Length (km)
Lawachara National Park	Eastern	24°19.9′ N, 91°47.6′ E; 24°20.2′ N, 91°47.5′ E	0.5
(area: 1,250 ha; year of establishment: 1996)	Central	24°19.7′ N, 91°47.2′ E; 24°19.8′ N, 91°47.5′ E	0.61
	Central	24°19.8′ N, 91°47.2′ E; 24°20.2′ N, 91°47.2′ E	0.5
	Central	24°19.5′ N, 91°47.2′ E; 24°19.7′ N, 91°47.6′ E	0.7
	Western	24°19.2′ N, 91°47.1′ E; 24°19.4′ N, 91°46.8′ E	0.52
	Western	24°18.8′ N, 91°46.4′ E; 24°19.1′ N, 91°46.9′ E	0.89
Satchari National Park	Central	24°07.5′ N, 91°26.7′ E; 24°06.6′ N, 91°27.2′ E	1.94
(area: 243 ha; year of establishment: 2006)	Central	24°07.6′ N, 91°27.0′ E; 24°07.3′ N, 91°27.2′ E	0.56
	Northern	24°07.4′ N, 91°26.7′ E; 24°07.5′ N, 91°27.0′ E	0.5
Rema-Kalenga Wildlife Sanctuary	Northern	24°10.7′ N, 91°37.6′ E; 24°09.6′ N, 91°38.0′ E	2.02
(area: 1,795 ha; year of establishment: 1996)	Central	24°09.6′ N, 91°38.0′ E; 24°09.8′ N, 91°37.5′ E	0.78
	Northern	24°10.2′ N, 91°37.5′ E; 24°10.3′ N, 91°37.9′ E	0.8
	Southern	24°06.9′ N, 91°37.5′ E; 24°06.4′ N, 91°37.8′ E	1.11
Chunati Wildlife Sanctuary	Eastern	21°55.4′ N, 92°03.5′ E; 21°55.3′ N, 92°02.7′ E	1.41
(area: 7,764 ha; year of establishment: 1986)	Central	21°55.3′ N, 92°02.7′ E; 21°55.5′ N, 92°02.3′ E	0.76
	Eastern	21°55.7′ N, 92°02.5′ E; 21°56.1′ N, 92°03.5′ E	1.91
	Northern	21°57.3′ N, 92°04.1′ E; 21°57.2′ N, 92°03.7′ E	0.65
	Northern	21°57.2′ N, 92°03.7′ E; 21°57.4′ N, 92°04.0′ E	0.65
Teknaf Game Reserve	Northern	21°05.8′ N, 92°09.8′ E; 21°05.2′ N, 92°10.2′ E	1.25
(area: 11,615 ha; year of establishment: 1983)	Northern	21°05.2′ N, 92°10.2′ E; 21°05.4′ N, 92°09.5′ E	1.27
	Northern	21°06.3′ N, 92°11.7′ E; 21°05.5′ N, 92°10.8′ E	0.74
	Central	21°05.2′ N, 92°11.9′ E; 21°03.9′ N, 92°11.6′ E	2.49
	Central	21°03.9′ N, 92°11.6′ E; 21°04.5′ N, 92°11.9′E	1.21

Any important or interesting observation or information relating to diet, foraging guild and threats was recorded opportunistically during the transects and at any time while in the field. The birds were identified from books such as Ali & Ripley (1987), Grimmett et al. (1998) and Rasmussen & Anderton (2005). Their relative abundance was assessed

by classifying sighting frequencies into four: 'Very Common'—recorded on 76–100% observation-days, 'Common'—recorded on 51–75% observation-days, 'Fairly Common'—recorded on 26–50% observation-days, and 'Few'—recorded on 25% or fewer observation-days.

Results

During the avian breeding season (February–August) of four consecutive years (2005–2008), 239 species of bird were recorded in the five protected areas, of which 189 were residents, 39 winter visitors, 6 summer visitors and 5 vagrants (see Appendix). The relative abundance shows that 40 (17%) species were 'Very Common', 66 (28%) 'Common', 48 (20%) 'Fairly Common' and 85 (35%) 'Few'. Based on principal diet 131 (55%) species were insectivorous, 32 (13%) carnivorous, 29 (12%) omnivorous, 23 (10%) granivorous and herbivorous, 17 (7%) frugivorous, and 7 (3%) nectarivorous. Based on principal foraging guild 100 (42%) species were middle canopy forager, 78 (33%) ground forager, 36 (15%) upper canopy forager, and 25 (10%) undergrowth and bush forager.

The site lists show that the total number of species and the total number of primarily forest species for Lawachara were 167 and 90, for Satchari 153 and 84, for Rema-Kalenga 206 and 91, for Chunati 162 and 53, and for Teknaf 188 and 73. It is evident that the ratio of total species to total forest species varied across the five sites.

Comparisons of annual mean density estimates from 2005 to 2008 revealed that two indicator species (Red Jungle fowl and Puff-throated Babbler), both of which live in the under storey, increased at every site and at all sites combined (Fig. 2). However, Oriental Pied Hornbill declined and the other five indicator species remained more or less unchanged over the four years (Fig. 2).

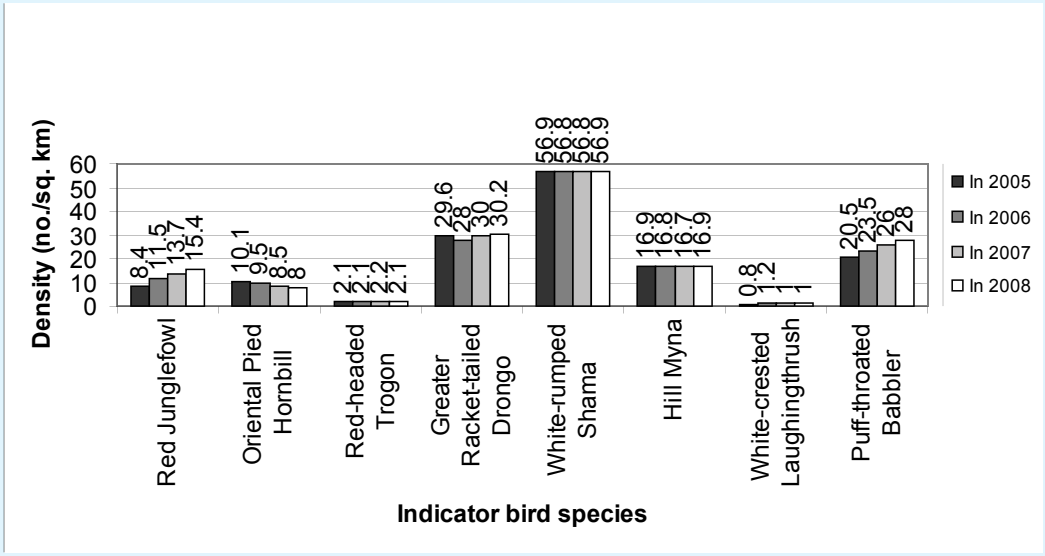

Figure 2. Comparison of the population density of eight indicator bird species across five NSP sites during 2005-2008

Two globally threatened species were recorded: White-rumped Vulture *Gyps bengalensis* (Critically Endangered) and Lesser Adjutant *Leptoptilos javanicus* (Vulnerable), plus one Near Threatened species was recorded: White-cheeked Partridge *Arborophila atrogularis*. Additionally, eleven nationally threatened species were recorded: Kalij Pheasant *Lophura leucomelanos*, Grey Peacock Pheasant *Polyplectron bicalcaratum*, Oriental Pied Hornbill, Red-headed Trogon, Dollarbird *Eurystomus orientalis*, Spot-bellied Eagle Owl *Bubo nipalensis*, Brown Fish Owl *Ketupa zeylonensis*, Tawny Fish Owl *Ketupa flavipes*, Malayan Night Heron *Gorsachius melanolophus*, Lesser Adjutant and Streaked Spider hunter *Arachnothera magna*.

A permanent nesting colony of White-rumped Vulture was found in Rema-Kalenga where the birds seen nesting in winter during the study period. A hatchling of White-cheeked Partridge was seen with parent in Lawachara on 15 March 2008. The parent bird uttered alarm call and finally ran away, but the fledgling crawled under fallen leaves and sat motionless. A pair of Oriental Pied Hornbill used the same tree-hole in Satchari for three consecutive years from 2005 to 2007 until the nestlings were stolen by people in 2007.

Discussion

The total bird species (239) recorded in five NSP sites represents over 30% of the birds recorded in Bangladesh (Khan 2008, Siddiqui et al. 2008), and almost 18% recorded in the Indian Subcontinent (Grewal et al. 2002). The bird species were recorded mainly during the transects while counting the indicator birds, so some species may have been missed either because they occurred away from the transects or because of observer bias (since attention was mainly placed on identifying and counting indicator birds). The cryptic nature of some birds might also have contributed to the crudeness of the relative abundance.

An increase of the density of two indicator species of bird (Red Jungle fowl and Puff-throated Babbler) would suggest that the forest under storey is regenerating and has consequently increased the carrying capacity and nesting sites for these two species. Community patrolling and awareness, and other programmes conducted by NSP played a key role in reducing the clearing of under storey vegetation for firewood as well as reducing hunting pressure. Illegal logging of timber trees and illegal harvest of forest fruits still persist, which probably caused the decline of the Oriental Pied Hornbill over the four years. This bird lives in the upper canopy and hence is severely affected if large trees are removed from the forest. Being a bird of under sotrey, White-crested Laughing thrush did not respond to the change as in case of Red Jungle fowl and Puff-throated Babbler. This is a rare species in Bangladesh and was found only in Chunati, which is more open compared to four other NSP sites. It is possible that White-crested Laughing thrush population had different limiting factors.

Habitat loss remains the main threat to birds in all five NSP sites. Illegal felling of trees and bamboo, and conversion of natural forests to monoculture plantations and agricultural fields, were witnessed during the survey. Hunting and trapping of birds, together with the taking of nestlings as cage birds (particularly mynas, parakeets and hornbills), is another threat. Large-scale illegal harvest of forest fruits, particularly *Artocarpus chaplasha* and *Bixa* sp., is a growing threat for frugivorous birds. Moreover, the excessive number of visitors in Lawachara and Satchari is becoming a threat to the wilderness. These threats should be reduced in order to maintain a healthy status of birds in the study's five protected areas.

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Appendix

List of bird species recorded in five NSP sites in the breeding season (February–August) during 2005–2008

Name of the Species	Principal Diet	Principal Foraging Guild	Status	Distribution
Blue-breasted Quail *Coturnix coromandelica*	g	gr	fc, R	C, T, RK
White-cheeked Partridge *Arborophila atrogularis* *	g	gr	fe, R	L, S, RK
Red Jungle fowl *Gallus gallus* *	g	gr	co, R	WI
Kalij Pheasant *Lophura leucomelanos* *	g	gr	fc, R	WI
Grey Peacock Pheasant *Polyplectron bicalcaratum* *	g	gr	fe, R	T, RK
Lesser Whistling-duck *Dendrocygna javanica*	g	gr	co, R	T, RK, C
Cotton Pygmy-goose *Nettapus coromandelianus*	g	gr	fe, R	T
Barred Buttonquail *Turnix suscitator*	g	gr	fc, R	C, T, RK
Eurasian Wryneck *Jynx torquila*	i	gr	fc, W	C, T, RK
White-browed Piculet *Sasia ochracea* *	i	m	fe, R	S, RK
Rufous Woodpecker *Celeus brachyurus*	i	m	co, R	WI
Great Slaty Woodpecker *Mulleripicus pulverulentus* *	i	u	fe, R	T, C
Grey-capped Pygmy Woodpecker *Dendrocopos canicapillus* *	i	m	fc, R	WI
Fulvous-breasted Woodpecker *Dendrocopos macei*	i	m	vc, R	WI
Lesser Yellownape *Picus chlorolophus* *	i	u	fe, R	L, C
Greater Yellownape *Picus flavinucha* *	i	u	co, R	WI
Grey-headed Woodpecker *Picus canus*	i	u	fe, R	L, S
Black-rumped Flameback *Dinopium benghalense*	i	m	vc, R	WI
Greater Flameback *Chrysocolaptes lucidus* *	i	u	vc, R	WI
Lineated Barbet *Megalaima lineata*	f	u	vc, R	WI
Blue-throated Barbet *Megalaima asiatica*	f	u	vc, R	WI
Blue-eared Barbet *Megalaima australis* *	f	u	fc, R	L, S, RK, T
Coppersmith Barbet *Megalaima haemacephala*	f	m	vc, R	WI
Oriental Pied Hornbill *Anthracoceros albirostris* *	f	u	fc, R	L, S, RK, T
Common Hoopoe *Upupa epops*	i	gr	co, R	C, T, RK
Red-headed Trogon *Harpactes erythrocephalus* *	i	m	fe, R	L, S, RK, T
Indian Roller *Coracias benghalensis*	i	gr	co, R	C, T, RK
Dollarbird *Eurystomus orientalis* *	i	u	fe, V	L, S, RK, T
Common Kingfisher *Alcedo atthis*	c	gr (water)	co, R	WI
Oriental Dwarf Kingfisher *Ceyx erithacus* *	c	gr (water)	fe, V	L, S

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
White-throated Kingfisher *Halcyon smyrnensis*	c	gr (water)	co, R	WI
Pied Kingfisher *Ceryle rudis*	c	gr (water)	fe, R	T
Blue-bearded Bee-eater *Nyctyornis athertoni* *	i	u	fe, R	WI
Green Bee-eater *Merops orientalis*	i	m	vc, R	WI
Blue-tailed Bee-eater *Merops philippinus* *	i	u	co, R	WI
Chestnut-headed Bee-eater *Merops leschenaulti* *	i	u	vc, R	WI
Pied Cuckoo *Clamator jacobinus*	i	m	fe, S	WI
Chestnut-winged Cuckoo *Clamator coromandus* *	i	m	fe, V	L, S, RK
Common Hawk Cuckoo *Hierococcyx varius*	i	m	vc, R	WI
Indian Cuckoo *Cuculus micropterus*	i	m	co, S	WI
Plaintive Cuckoo *Cacomantis merulinus*	i	m	co, R	WI
Asian Emerald Cuckoo *Chrysococcyx maculatus* *	i	m	fe, S	S
Violet Cuckoo *Chrysococcyx xanthorhynchus* *	i	m	fe, S	S
Drongo Cuckoo *Surniculus lugubris* *	i	u	co, R	L, S, RK, T
Asian Koel *Eudynamys scolopacea*	i	m	vc, R	WI
Green-billed Malkoha *Phaenicophaeus tristis* *	i	m	vc, R	WI
Greater Coucal *Centropus sinensis*	i	gr	vc, R	WI
Lesser Coucal *Centropus bengalensis* *	i	u	co, R	WI
Vernal Hanging Parrot *Loriculus vernalis* *	g	m	fc, R	L, S, RK, T
Rose-ringed Parakeet *Psittacula krameri*	f	u	co, R	WI
Blossom-headed Parakeet *Psittacula roseata* *	f	u	fc, R	L, S, RK
Red-breasted Parakeet *Psittacula alexandri* *	f	m	vc, R	WI
Asian Palm Swift *Cypsiurus balasiensis*	i	u (mid-air)	co, R	C, T, RK
Fork-tailed Swift *Apus pacificus*	i	u (mid-air)	fe, W	T
Oriental Scops *Owl Otus sunia* *	i	m	fe, R	L, S, RK
Collared Scops Owl *Otus bakkamoena*	i	m	fe, R	WI
Spot-bellied Eagle Owl *Bubo nipalensis* *	c	m	fe, R	T
Dusky Eagle Owl *Bubo coromandus* *	c	m	fe, R	RK
Brown Fish Owl *Ketupa zeylonensis*	c	m	fe, R	WI
Tawny Fish Owl *Ketupa flavipes* *	c	m	fe, R	RK, T
Brown Wood Owl *Strix leptogrammica* *	c	m	fe, R	L, RK
Asian Barred Owlet *Glaucidium cuculoides* *	i	m	co, R	WI
Spotted Owlet *Athene brama*	i	m	vc, R	WI
Brown Hawk Owl *Ninox scutulata*	i	m	co, R	WI

Name of the Species	Principal Diet	Principal Foraging Guild	Status	Distribution
Large-tailed Nightjar *Caprimulgus macrurus* *	i	m (mid-air)	co, R	WI
Rock Pigeon *Columba livia*	g	gr	co, R	WI
Green Imperial Pigeon *Ducula aenea* *	f	u	fe, R	L, S, RK
Oriental Turtle Dove *Streptopelia orientalis* *	g	m	fe, R	L, S, RK
Spotted Dove *Streptopelia chinensis*	g	gr	vc, R	WI
Red Collared Dove *Streptopelia tranquebarica*	g	gr	co, R	WI
Eurasian Collared Dove *Streptopelia decaocto*	g	gr	co, R	WI
Barred Cuckoo Dove *Macropygia unchall* *	g	m	fe, R	S
Emerald Dove *Chalcophaps indica* *	g	gr	vc, R	WI
Orange-breasted Green Pigeon *Treron bicincta* *	f	m	fe, R	L, S, RK
Pompadour Green Pigeon *Treron pompadora* *	f	m	co, R	WI
Thick-billed Green Pigeon *Treron curvirostra* *	f	m	fe, R	L, S, RK
Yellow-footed Green Pigeon *Treron phoenicoptera*	f	m	co, R	WI
Wedge-tailed Green Pigeon *Treron sphenura* *	f	u	fe, R	L, S, RK
White-breasted Waterhen *Amaurornis phoenicurus*	i	gr	fc, R	RK, C, T
Pintail Snipe *Gallinago stenura*	i	gr	fe, W	RK, C, T
Common Snipe *Gallinago gallinago*	i	gr	fe, W	RK, C, T
Green Sandpiper *Tringa ochropus*	i	gr	fe, W	RK, C, T
Wood Sandpiper *Tringa glareola*	i	gr	co, W	RK, C, T
Common Sandpiper *Actitis hypoleucos*	i	gr	co, W	RK, C, T
Greater Painted Snipe *Rostratula benghalensis*	i	gr	fc, R	RK, C, T
Bronze-winged Jacana *Metopidius indicus*	g	gr	fc, R	C
Little Ringed Plover *Charadrius dubius*	i	gr	fe, W	C
Red-wattled Lapwing *Vanellus indicus*	i	gr	fc, R	RK, C, T
Little Tern *Sterna albifrons*	c	gr (water)	fc, R	T
Whiskered Tern *Chlidonias hybridus*	c	gr (water)	fc, W	T
Osprey *Pandion haliaetus*	c	gr (water)	fe, W	T
Jerdon's Baza *Aviceda jerdoni* *	c	u	fe, R	L, S, RK
Black Baza *Aviceda leuphotes* *	c	u	fc, R	L, S, RK, T
Oriental Honey-buzzard *Pernis ptilorhynchus*	i (while feeding honey-comb)	m	fc, R	W
Black-shouldered Kite *Elanus caeruleus*	i	gr	fc, R	C, T, RK
Black Kite *Milvus migrans*	c	gr	fc, R	C, T, RK, S
Brahminy Kite *Haliastur indus*	c	gr	co, R	WI
White-rumped Vulture *Gyps bengalensis*	c (carrion)	gr	fc, R	RK, C, T

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
Himalayan Griffon *Gyps himalayensis*	c (carrion)	gr	fe, V	RK
Crested Serpent Eagle *Spilornis cheela* *	c	m	vc, R	WI
Shikra *Accipiter badius* *	c	m	fc, R	WI
Besra *Accipiter virgatus* *	c	m	fc, R	WI
Changeable Hawk Eagle *Spizaetus cirrhatus* *	c	m	fe, R	L, S, RK
Common Kestrel *Falco tinnunculus*	i	gr	fc, W	WI
Amur Falcon *Falco amurensis*	i	u (mid-air)	fe, W	L, RK
Little Cormorant *Phalacrocorax niger*	c	gr (water)	fe, R	T
Little Egret *Egretta garzetta*	c	gr	fc, R	C, T, RK
Cattle Egret *Bubulcus ibis*	c	gr	fc, R	C, T, RK
Indian Pond Heron *Ardeola grayii*	c	gr	vc, R	C, T, RK, L
Black-crowned Night Heron *Nycticorax nycticorax*	c	gr	fe, R	RK, C, T
Malayan Night Heron *Gorsachius melanolophus* *	c	gr	fe, V	L, RK
Yellow Bittern *Ixobrychus sinensis*	c	gr	fe, R	T, C
Cinnamon Bittern *Ixobrychus cinnamomeus*	c	gr	fc, R	RK, C, T
Asian Openbill *Anastomus oscitans*	c (snail)	gr	fe, R	RK
Lesser Adjutant *Leptoptilos javanicus*	c	gr	fe, R	RK
Blue-naped Pitta *Pitta nipalensis* *	i	gr	fe, R	RK, L, S, T
Hooded Pitta *Pitta sordida* *	i	gr	fe, S	S, L, RK
Asian Fairy Bluebird *Irena puella* *	f	m	co, R	L, S, RK, T
Blue-winged Leafbird *Chloropsis cochinchinensis* *	i	m	fe, R	L, T
Golden-fronted Leafbird *Chloropsis aurifrons* *	i	m	vc, R	WI
Brown Shrike *Lanius cristatus*	i	b	co, W	WI
Long-tailed Shrike *Lanius schach*	i	b	co, R	WI
Grey-backed Shrike *Lanius tephronotus*	i	b	fc, W	WI
Common Green Magpie *Cissa chinensis* *	o	m	fe, R	S, L, T
Rufous Treepie *Dendrocitta vagabunda*	o	m	co, R	WI
Grey Treepie *Dendrocitta formosae* *	o	m	fc, R	L, S, RK, T
House Crow *Corvus splendens*	o	gr	fc, R	C, T, RK
Large-billed Crow *Corvus macrorhynchos*	o	gr	co, R	WI
Ashy Woodswallow *Artamus fuscus*	i	u (mid-air)	fc, R	WI
Black-naped Oriole *Oriolus chinensis* *	o	m	fe, W	L, S, RK
Black-hooded Oriole *Oriolus xanthornus*	o	m	vc, R	WI
Maroon Oriole *Oriolus traillii* *	o	u	fe, R	L, S, RK

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
Large Cuckooshrike **Coracina macei**	o	m	co, R	WI
Black-winged Cuckooshrike *Coracina melaschistos* *	o	m	fe, W	L, S, RK
Black-headed Cuckooshrike *Coracina melanoptera*	o	m	fe, R	RK
Rosy Minivet *Pericrocotus roseus* *	i	u	fe, R	L, S, RK
Ashy Minivet *Pericrocotus divaricatus* *	i	u	fe, R	L, RK
Small Minivet *Pericrocotus cinnamomeus* *	i	u	vc, R	WI
Scarlet Minivet *Pericrocotus flammeus* *	i	u	co, R	WI
Bar-winged Flycatcher-shrike *Hemipus picatus* *	i	m	fc, R	L, S, RK
White-throated Fantail *Rhipidura albicollis*	i	b	co, R	WI
Black Drongo *Dicrurus macrocercus*	i	m	vc, R	WI
Ashy Drongo *Dicrurus leucophaeus*	i	m	fe, W	WI
Bronzed Drongo *Dicrurus aeneus* *	i	m	vc, R	WI
Lesser Racket-tailed Drongo *Dicrurus remifer* *	i	u	fe, W	L, S, RK
Spangled Drongo *Dicrurus hottentottus* *	i	m	co, R	WI
Greater Racket-tailed Drongo *Dicrurus paradiseus* *	i	u	co, R	WI
Black-naped Monarch *Hypothymis azurea* *	i	b	co, R	WI
Common Iora *Aegithina tiphia*	i	m	vc, R	WI
Large Woodshrike *Tephrodornis gularis* *	i	u	co, R	L, S, RK
Common Woodshrike *Tephrodornis pondicerianus* *	i	m	co, R	WI
Blue Rock Thrush *Monticola solitarius*	i	gr	fc, W	WI
Blue Whistling Thrush *Myophonus caeruleus* *	i	gr	fe, R	T
Orange-headed Thrush *Zoothera citrina*	i	gr	fe, R	WI
Red-throated Flycatcher *Ficedula parva*	i	m	vc, W	WI
Verditer Flycatcher *Eumyias thalassina* *	i	u	fc, W	WI
Pale-chinned Flycatcher *Cyornis poliogenys* *	i	m	fe, R	RK, L, S
Grey-headed Canary Flycatcher *Culicicapa ceylonensis*	i	m	c, R	WI
Oriental Magpie Robin *Copsychus saularis*	i	gr	vc, R	WI
White-rumped Shama *Copsychus malabaricus* *	i	gr	co, R	WI
Black Redstart *Phoenicurus ochruros*	i	b	fe, W	RK, C, T
Black-backed Forktail *Enicurus immaculatus* *	i	gr	fe, R	RK, T
Common Stonechat *Saxicola torquata*	i	b	co, W	RK, C, T
Pied Bushchat *Saxicola caprata*	i	b	fe, R	C, T
Asian Glossy Starling *Aplonis panayensis* *	f	m	fe, W	T
Chestnut-tailed Starling *Sturnus malabaricus*	f	m	vc, R	WI

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
Asian Pied Starling *Sturnus contra*	o	gr	vc, R	WI
Common Myna *Acridotheres tristis*	o	gr	vc, R	WI
Bank Myna *Acridotheres ginginianus*	o	gr	fe, R	RK, C, T
Jungle Myna *Acridotheres fuscus*	o	m	vc, R	WI
Hill Myna *Gracula religiosa* *	o	u	co, R	WI
Velvet-fronted Nuthatch *Sitta frontalis* *	i	m	fc, R	RK, L, S
Great Tit *Parus major*	i	m	vc, R	WI
Barn Swallow *Hirundo rustica*	i	u (mid-air)	co, W	WI
Black-headed Bulbul *Pycnonotus atriceps* *	o	m	fc, R	WI
Black-crested Bulbul *Pycnonotus melanicterus* *	o	m	co, R	WI
Red-whiskered Bulbul *Pycnonotus jocosus*	o	m	vc, R	WI
Red-vented Bulbul *Pycnonotus cafer*	o	m	vc, R	WI
White-throated Bulbul *Alophoixus flaveolus* *	o	m	co, R	WI
Olive Bulbul *Iole virescens* *	o	m	fe, R	RK, L, S
Ashy Bulbul *Hemixos flavala* *	o	m	fe, R	L, RK
Grey-breasted Prinia *Prinia hodgsonii*	i	b	co, R	WI
Plain Prinia *Prinia inornata*	i	b	fc, R	C, T, RK
Zitting Cisticola *Cisticola juncidis*	i	b	co, R	WI
Oriental White-eye *Zosterops palpebrosus*	i	m	vc, R	WI
Blyth's Reed Warbler *Acrocephalus dumetorum*	i	b	co, W	WI
Striated Grassbird *Megalurus palustris*	i	b	fc, R	C, T
Common Tailorbird *Orthotomus sutorius*	i	b	vc, R	WI
Dark-necked Tailorbird *Orthotomus atrogularis* *	i	b	fc, R	T, C
Dusky Warbler *Phylloscopus fuscatus*	i	b	fc, W	WI
Tickell's Leaf Warbler *Phylloscopus affinis*	i	m	fc, W	WI
Yellow-browed Warbler *Phylloscopus inornatus*	i	m	co, W	WI
Greenish Warbler *Phylloscopus trochiloides*	i	m	fc, W	WI
Blyth's Leaf Warbler *Phylloscopus reguloides*	i	m	fc, W	L, S, RK
Yellow-vented Warbler *Phylloscopus cantator*	i	m	fc, W	L, RK
Golden-spectacled Warbler *Seicercus burkii*	i	m	fe, S	L, RK
Grey-hooded Warbler *Seicercus xanthoschistos*	i	m	fe, W	L, RK
White-crested Laughingthrush *Garrulax leucolophus* *	i	b	fe, R	C, T
Lesser Necklaced Laughingthrush *Garrulax moniliger* *	i	m	fe, R	RK, L, C
Greater Necklaced Laughingthrush *Garrulax pectoralis* *	i	m	co, R	WI

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
Rufous-necked Laughingthrush *Garrulax ruficollis* *	i	b	co, R	WI
Abbott's Babbler *Malacocincla abbotti* *	i	b	vc, R	WI
Puff-throated Babbler *Pellorneum ruficeps* *	i	b	co, R	WI
Large Scimitar Babbler *Pomatorhinus hypoleucos* *	i	m	fe, R	L, RK, T
White-browed Scimitar Babbler *Pomatorhinus schisticeps* *	i	b	fe, R	L, S, RK
Grey-throated Babbler *Stachyris nigriceps* *	i	b	fe, R	C, T
Striped Tit Babbler *Macronous gularis* *	i	b	co, R	WI
Chestnut-capped Babbler *Timalia pileata* *	i	b	fe, R	C, T
Yellow-eyed Babbler *Chrysomma sinensis* *	i	b	fe, R	C, T
Brown-cheeked Fulvetta *Alcippe poioicephala* *	i	m	fe, R	L
Nepal Fulvetta *Alcippe nipalensis* *	i	m	fe, R	RK
Rufous-winged Bushlark *Mirafra assamica*	g	gr	co, R	WI
Thick-billed Flowerpecker *Dicaeum agile*	o	m	fc, R	RK, C, T
Yellow-vented Flowerpecker *Dicaeum chrysorrheum* *	o	m	fe, R	L, RK, T
Orange-bellied Flowerpecker *Dicaeum trigonostigma* *	o	m	fe, R	T
Pale-billed Flowerpecker *Dicaeum erythrorynchos*	o	m	co, R	WI
Plain Flowerpecker *Dicaeum concolor*	o	m	co, R	L, RK, T
Scarlet-backed Flowerpecker *Dicaeum cruentatum* *	o	m	vc, R	WI
Ruby-cheeked Sunbird *Anthreptes singalensis* *	n	m	fc, R	WI
Purple-rumped Sunbird *Nectarinia zeylonica*	n	m	fc, R	RK, L, C, T
Purple-throated Sunbird *Nectarinia sperata* *	n	m	co, R	WI
Purple Sunbird *Nectarinia asiatica*	n	m	vc, R	WI
Crimson Sunbird *Aethopyga siparaja* *	n	m	vc, R	WI
Little Spiderhunter *Arachnothera longirostra* *	n	m	vc, R	WI
Streaked Spiderhunter *Arachnothera magna* *	n	m	fe, R	T
House Sparrow *Passer domesticus*	g	gr	co, R	WI
Forest Wagtail *Dendronanthus indicus* *	i	gr	co, W	WI
White Wagtail *Motacilla alba*	i	gr	co, W	RK, L, C, T
White-browed Wagtail *Motacilla maderaspatensis*	i	gr	co, R	RK, L, C, T
Citrine Wagtail *Motacilla citreola*	i	gr	fe, W	RK, C, T
Grey Wagtail *Motacilla cinerea*	i	gr	fc, W	RK, C, T
Paddyfield Pipit *Anthus ruficollis*	i	gr	co, R	RK, C, T
Olive-backed Pipit *Anthus hodgsoni* *	i	gr	co, W	WI

Name of the Species	Principal Diet	Principal For-aging Guild	Status	Distribution
Rosy Pipit *Anthus roseatus*	i	gr	fe, W	RK
Baya Weaver *Ploceus philippinus*	i	gr	co, R	WI
Indian Silverbill *Lonchura malabarica*	g	gr	fe, R	RK, C, T
White-rumped Munia *Lonchura striata* *	g	gr	fc, R	WI
Scaly-breasted Munia *Lonchura punctulata*	g	gr	co, R	RK, C, T
Black-headed Munia *Lonchura malacca*	g	gr	fe, R	RK, C, T

* Primarily forest species.

Key

Principal Diet: o – Omnivore, g – Granivore and Herbivore, f – Frugivore, n – Nectarivore, i – Insectivore, and c – Carnivore (including Piscivore). Principal Foraging Guild: gr – Ground, b – Bush and Undergrowth, m – Middle Canopy, and u – Upper Canopy. Status: vc – Very Common, co – Common, fc – Fairly Common, and fe – Few (in NSP sites); R – Resident, W – Winter Visitor, S – Summer Visitor, and V – Vagrant (in Bangladesh). Distribution: WI – Wide (all NSP sites), L – Lawachara, S – Satchari, RK – Rema-Kalenga, C – Chunati, and T – Teknaf.

Knowledge, attitude and perception of local people of Baiddyamari village towards tiger conservation: A case study from the Sundarbans of Bangladesh

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Abstract

An empirical study on the knowledge, attitude and perception of local people towards tiger conservation was carried out using qualitative research techniques in a small village in the vicinity of the Bangladesh Sundarbans. Face to face interview was done using a semi-structured questionnaire schedule. The study location was selected purposively considering the potential instances of human animal conflicts in the location. From the study it was revealed that the people of the study area perceive poor level of knowledge and understanding regarding tiger behavior. The level of perception regarding tiger conservation found moderate as well as positive attitude. The respondents believed that the number of tiger and its prey has been declined in the last decade. The respondents (61%) showed a little or no idea about the tiger derivative traditional medicine which is a good indicator in tiger conservation in this part of the world. Rapid and extensive outreach program is imperative to enhance the conservation awareness and related activities among the local people.

Key words: *Perception, attitude, local people, tiger conservation, human-tiger conflict*

Introduction

Knowledge can be defined as an acquaintance, familiarity or understanding or something, such as facts, information, descriptions, which is acquired through experience or education by perceiving, discovering, or learning. Knowledge can refer to a theoretical or practical understanding of a subject. It can be implicit or explicit. The attitude can be referred to as an expression of favor or disfavor toward a person, place, thing, or event and on the other hand the perception can be expressed as the organization, identification, and interpretation of sensory information in order to represent and understand the environment (www.wikipedia.org). In the world of wildlife conservation people's attitudes towards conservation and protected areas have been revealed by various quarters of scientists and researchers around the world. (Sekhar, 2003; Arjunan et al., 2006; Tomićević et al., 2009). In most of the cases it has been revealed that the local people have encouraging approaches to the conservation concept (Carr and Tait, 1991; Newmark et al., 1993; Sekhar, 2003; Arjunan et al., 2006). Romañach et al. (2007) and Tomićević et al. (2009) manifested multifaceted factors that influence public attitude. They experienced a positive correlation between level of education and the attitude of people .towards conservation. However another study conducted by, Gadd (2005) did not find any correlation between attitude and education. Infield (1988) mentioned about economic aspects of local people in wildlife management. He found that people with a high income and a large capital believe in conservation than those with less resource. In addition, Arjunan et al. (2006) opines that it is those who have the least to lose that are most positive. Infield (1988), Daoutopoulos and Pyrovetsi (1990), Newmark et al. (1993), Lindsey et al. (2005) and Arjunan et al. (2006) observed that the public opinion for conservation varies as per the land use pattern of the community and it varies significantly in different scenarios. However, the human-wildlife conflict (HWC) is a widespread phenomenon from the past and has become a significant issue throughout the world (Wang & Macdonald, 2005). In Bangladesh, the context of HWC is quite old but received attention of the policy makers, practitioners, community people and conservationist in recent times. Considering the significance and extent of conflicts, the government has also formulated rules (Compensation for the wildlife victims rules, 2010) to deal with the issues. The human tiger conflict (HTC) in the Sundarbans area is considered as one of the old problems in tiger conservation in Bangladesh. The killing of human, livestock depredation by tiger and killing of tiger in the Sundarbans area are the example of HTC at its most extreme. These consequences of HTC resulted in the acceleration of anger and among the victims thus lead to retribution killings (Barlow 2009). It has been found that from 2000 to 2010, a total of 15 stray tigers had been killed by the agitated mob and on the other hand 223 persons were killed in the forests by tiger an average casualty of 23 persons per year (Wildlife Management and Nature Conservation Division, Khulna, 2012). Regarding livestock depredation in the Sundarbans, Rahman et al. (2009) conducted a study and reported highest livestock depredation in the Chandpai Range (92%) significantly higher than any other ranges. Among many factors, the authors found a significant relationship with the width of the khal and the number of livestock depredation incidences;

where livestock easily cross khals with a width of less than 25 m to enter the adjacent forest for grazing, which increases availability of livestock as potential prey for tigers in these areas, and might increase familiarity of tigers to this prey type. The study also revealed 28 incidence of livestock depredation in the Baiddyamari village where 6 were inside the forests and 22 were inside the village (Rahman et al. 2009). The last stray tiger incidence in the Baiddyamari village was in 2007 (Sundarban East Forest Division 2012). However, the numbers of humans and tigers killed each year have gone down in the recent decades, but current levels of conflict severely impacts local communities and may be a serious impediment to tiger conservation (Barlow 2009).

Bangladesh is one of the 13th tiger landscape countries in the world and the Sundarbans Reserved Forests (SRF) is considered last remaining strongholds of the Bengal tiger (Pathera tigris tigris) (Barlow 2009) in Bangladesh. Bengal tiger in the SRF play a significant role in maintaining the ecosystem by way of predation and inter-specific competition (Treves and Karanth 2003). The people live around the Sundarbans and this area is considered as one of the worst Human-Tiger Conflict (HTC) area of the world. The result of the conflict is human-killing by tigers which produces unnecessary human desolation and economic stress, while tigers that enter villages are often killed in return (Gani 2002). This loss of people and livestock play a role to create negative attitudes towards tigers and in some cases retaliation killings by local communities (Jagroto Jubo Shangha 2003; Jalais 2007; Gurung et al. 2008). The attitudes, perception and feelings of local people concerning conservation policies and wildlife conflicts affect their behavior and understanding-this is significant in involving local people in conservation planning and decision-making processes (Wang et al. 2006). HTC in the Sundarbans results in not only into the death of human but also the killing of livestock. In most of the cases, the livestock are the means of livelihood of those community people who own them. The loss of livestock put them into an economical loss thus creates a hindrance in tiger conservation. On the other hand, the loss of human life due to tiger attack is also one of the negative major psychological perceptions towards the tiger conservation efforts of the government as well as the non-government organizations. However, now-a-days, conservationists have realized that the condition for a successful conservation project also includes a good relation and collaboration with local residents in and around the forest ecosystem (Newmark et. al. 1993; Sekhar 2003). For having a good cooperation and support there is a need of understanding of community awareness level which is dependent on the identification of the level of knowledge, attitude and perception of the local people towards wildlife conservation (Shayaa et al. 2007). However, presently no or very few research work has been done to assess the level of knowledge about tiger behavior, attitude of the local people towards tiger conservation and their perception about tiger conservation in the Bangladesh Sundarbans. Therefore, considering the above mentioned problem statement; the objective of the present study is to assess the knowledge, attitude and perception of local people of Baiddyamari village towards tiger conservation in the Bangladesh Sundarbans. Materials and methods.

The study was conducted in one of the Northern fringe villages of the Sundarbans named Baiddyamari. The village was selected purposively as study location considering the severity and intensity of occurrence. Baiddyamari is a small village (N22° 24' 02.8" and E 089° 39° 39.4°) in the Mongla Sub-district of Bagerhat in Bangladesh (Fig 1). The village is 12 km South-West of Bagerhat town. We selected the village purposively and all of the households were interviewed. The village was located just beside the Sundarbans. The distance from the Sundarbans varies from 15 meter to 50 meters. The village had only 64 households. All the inhabitants were Muslims and highly dependent on the forests for their livelihood (Biswash 2009). The head (male-70%) of the family was interviewed. I interviewed the female (30%) in case of the absence of the male. All of the households were interviewed. We interviewed the respondents using a mixed kind of questionnaire (structured and semi-structured questionnaire to have related information. The first part of the questionnaire was on demographic and personal and the second part was on the information related to knowledge, attitude and perception of them towards tiger conservation in the Sundarbans.

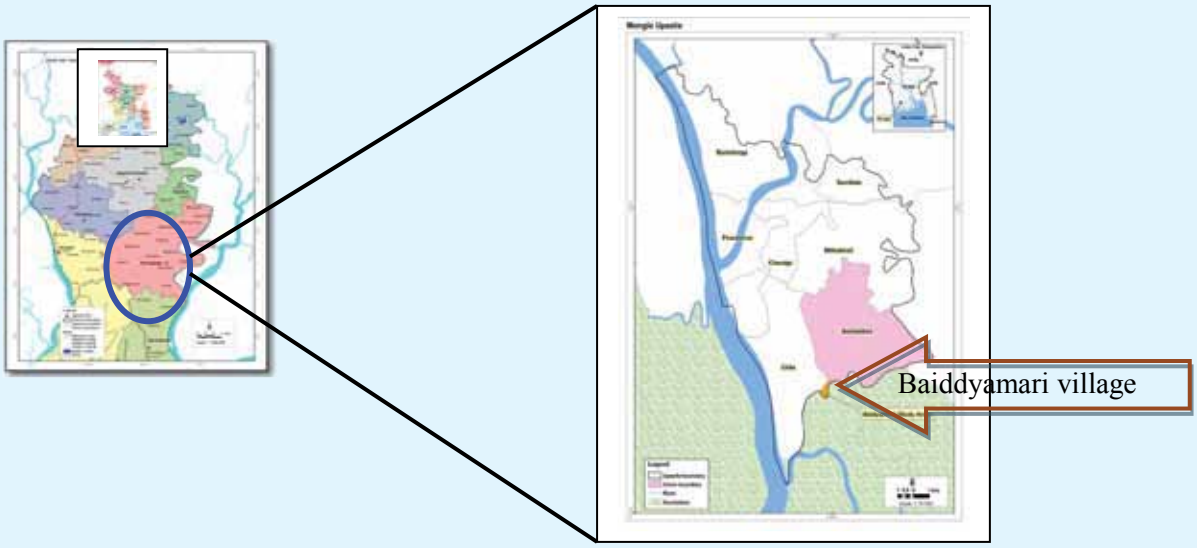

Figure 1: Baiddyamari village: study area

We followed 5-point Likert scale type (strongly agree, agree, neither, disagree and strongly disagree) to get the attitude and perception of the respondents and we put the knowledge score under correct, partially correct, do not know and incorrect and marked accordingly. The questionnaire survey was conducted within October 2012 to November 2012. The data were digitized and analyzed by using SPSS v.16.

Results and Discussion

The study done in the village was to explore the level of knowledge of the people about tiger. The people were also interviewed to get their attitude and perception towards tiger conservation of the Sundarbans. However the result of the study regarding knowledge, attitude and perception are briefly mentioned below:

Knowledge level of the people

The study revealed that the people of Baiddyamari possess poor level of knowledge on tiger behavior. Seventy three percent of the respondents could not answer (do not know 54%+ incorrect 19%) and only 27% gave answer which were correct and partially correct. It was also revealed in the study in the Baiddyamari village that the male answered more correctly female (Fig. 16) and a significant difference between the male and female respondents (2=18.152, df = 7, P<0.05) was also observed. The difference in the knowledge between male and female was found significant which might be an impediment for tiger conservation in the area. Ericsson and Heberlein (2003) found that the more knowledgeable people are about carnivores in their area, the more tolerant they tend to be of their presence. On the other hand, Conover (2002) mentioned that knowledgeable people are also more likely to behave in a way that lessens the chance of conflict arising in the first place. On the contrary, Tarrant et al (1997) in the US, noticed that there was weak correlation coefficient (r=0.30) with values and attitude towards wildlife. In spite of this, misinformation and a lack of knowledge about carnivores had been allied with higher human-wolf conflicts in southern Europe (Meriggi and Lovari 1996). However, increase in knowledge within the communities in proximity to the forest area can raise awareness for wildlife conservation. Marker and Dickman (2004) were apparently successful in improving attitudes towards cheetahs through widespread environmental education programs focused on cheetah. Findings of these studies implied that if local people show antagonism and have little knowledge about carnivores in their area, then investing in conservation education could potentially be a valuable strategy for conflict mitigation (Conforti and de Azevedo 2003; Kellert et al. 1996). People with better education and more knowledge about wildlife are also those who are more likely to be employed in tourism initiatives (Ashley et al. 2000), which makes the true reason for positive views towards wildlife.

Attitude of the people

The result showed people of the Baiddyamari village bear positive attitude towards the tiger and its conservation. It was found that 61-79 % respondents strongly agreed with the statement related to the importance of tiger in the Sundarbans. A majority of the respondents (55%) respondents disagreed with the statement that all the tigers in the Sundarbans were

not man eater. More than 60% respondents were found proud of tiger's presence in the Sundarbans. People of the study village wanted tiger to be conserved in the forest but they were not ready to see the stray tiger in their village. However, the tendency of killing stray tiger is not very uncommon in the Sundarbans. It was found in the survey that 91% (58) of respondents lost their relations in the forests during last ten years and 48.5% respondents lost their livestock due to tiger attack. In the study it was found that there was no significant relationship between "losing livestock" and attitude was observed (Spearman's rho, r = 0.113) which was similar to the study of Liu et al. (2011). They found that attitudes were more negative among who had interactions with bears or lived where bear encounters were more likely. Oli et al. (1994), Bagchi and Mishra (2006) and Lucherini and Merino (2008) also observed negative attitude of people towards large carnivores. However the study revealed that people of the study village bear positive attitude but it changes when they were personal affected.

Perception of the people

The conducted study revealed that the residents possessed moderate level of perception towards tiger conservation. There was much variation in responses in the perception score. In our study we found that 31% (20) respondents opined that prey poaching in the Sundarbans has increased, while 39% (25) respondents were in "neither agree nor disagree" situation which means they were not sure about the status of deer poaching in the forests and rest 30% respondents were disagreed with the statement that the number of deer in the forests is decreasing. The study revealed that 18% (11) respondents believed that tiger poaching was in the place. Among the respondents, 55% (35) were found in "neither agree nor disagree" situation on the tiger poaching incidents. However, this study revealed that the people living around the Sundarbans are generally unaware about this and 15% (9) of them do not believe that tiger body parts are useful for human ailments. This is a good indication that tigers in the Sundarbans are not poached by the local people for medicinal purposes. Though forest department is supposed to manage stray tiger but without the help from the local communities, it is impossible to save the tiger because often the tiger is bludgeoned to death. A majority portion of the respondents 60 %(38) were disagreed that it was not only the duty of FD to manage stray tiger.

Conclusion

Tiger conservation in the Sundarbans cannot bring success ignoring human aspects of natural resource management. Hitherto forest administration has paid little attention to this dimension of resource conservation. To cope with problem proper identification of causes of resource depletion, attitude, knowledge, tolerance level, etc. need to be evaluated. The study was a very small step to understand attitude, knowledge and perception of the communities around the Sundarbans towards tiger conservation. So there lies a great need to undertake such studies covering wider area for effective tiger conservation in the Sundarbans Reserved Forests.

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Fish conservation efforts in Bangladesh: How to make it more effective

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Abstract

The very zoo-geographic position of the deltaic Bangladesh support diverse fisheries potential enriched by its aquatic resources like rivers, beels, ponds,khals, flood plains as well as the coastline, Exclusive Economic Zone (EEZ) in the Bay of Bengal, fishing villages and fishers relying on nearly 265 species of freshwater and 442 species of marine fishes. Besides, there are aquatic animals like mollusks, echinoderms, amphibians, turtles, snakes, aquatic birds, whales, dolphins, otters, etc. The desired national fisheries policy aims to meet the fish production target of the country at a sustainable level besides it conservation. It is expected to boost export offisheries products, increase per capita national fish protein intake; ensure sustainable development of fisheries and socio-economic security of the fishers. It seems the existing fisheries policies and laws are failing to address issues related to the subject. Lacks of awareness, manpower, inter organizational conflicts etc. are the major concern to averting the law in enforce. Further this paper will focus on the improvement of such polices /legislations needed for the conservation and sustainable utilization of fishes in Bangladesh.

Introduction

Bangladesh prevail diverse ecological status which favourvarious flora and faunal composition in its small territory. The resources distributed in 39, 16,828 ha of inland open water for capture fisheries, 7,82,559ha of inland closed water for aquaculture and 1,18,813 sq. km of marine water area for artisanal and trawl fishing. The recent freshwater and marine fisheries resources are reviewed by Azheret al. (2014) and Naser (2014a) respectively. To protect and conserve the fish and other aquatic resources of Bangladesh, there are few policies and laws are available.In addition several conflicts with other governmental agencies result in misappropriate handling the conservation effort of the aquatic resources. The compliance of coastal and marine fisheries is covered in other paper of this proceedingby Hoq (2014) and some aspects in freshwater by Mohammad (2014). This paper, in general, focuseson the major policies andlaws related to thefish conservation in inland waters and their implications in the conservation and sustainable fisheries resources management in the territory of Bangladesh.

Fisheries planning of Bangladesh

The responsibility of planning and overall coordination of the fisheries sector is by the Department of Fisheries under the Ministry of Fisheries and Livestock. However, the national planning for fisheries is led by the Planning Commission of Ministry of Planning under the Members of a division and related functional Wings. Since its independence, usually the planning was done through a five years plan. The first five years plan (FFYP) was installed in 1972-73 towards 1977-78. The recent 6th five year plan (SFYP) is in- place for the fiscal years 2011 to 2015. As it was covered all aspects of the country, the fisheries plan was summarized in few pages. The first fisheries development plan of the land i.e. the FFYP was emphasized on the fish production increase and to maximize the utilization of natural resources to improve the socioeconomic conditions of the fishers and the export economy of the country (Karim, 1978). After four decades, the SFYP the major strategies was given to production increase through community based management, enhance productivity in shrimp culture and optimal fishing in marine waters(PC, 2014). The fisheries management in the open waters are offered by re-introduction of fish species, pen or cage culture, ban on fishing in certain fish or time period or season, and to introduce fish-sanctuaries. There was no sole known policyexclusively for fisheries in Bangladesh till 1989 and later in 1998.A detailed review of the fisheries sector was done in 2003 published in several volumes as 'The Future of Fisheries'. A complete National Fisheries Policy was in place few years later in 2006, which accounted eight major areas of strategies. The conservation tactic and experiences of transboundary migratory Hilsa fish in Bangladesh is recently reviewed by Naser (2014b).

Fisheries legislations related to fish conservation

The parliament is the sole authorities of the approval of a legislation or law. Under this process of the republic, a demand of law is felt, the relevant department will formulate a bill and shall pass it to the ministry. An interdepartmental/ministerial panel will approve the issue and then put forward to the ministry of law. The law shall be placed to the parliament by the relevant ministry. After passing it becomes Act and an official document is put forward as Gazette. Any future change is

known as amendments. The major fisheriesacts and rules of Bangladesh related to fish conservation implemented by the Department of Fisheries are as follows:

- Tank Improvement Act, 1939:
- Fish Protection & Conservation Act,1950 (amended in 1995)
- The protection and Conservation of Fish Rules, 1985 (amended in 2004, 2008, 2014)
- Fish Hatchery Act, 2010; and
- Fish Hatchery Regulation, 2011.
- National Shrimp Policy 2014

By implementing Tank Improvement Act, 1939 fisheries department can take hold of a waterbody to improve its fishery.

The Fish Protection and Conservation Act, 1950 was further verified in 1985 as rules. The rules were amended in 2004, to protect the Jatka (Juvenile Hilsa), while in 2008 amended to protect the brood Hilsa in spawning ground by declaring the time as ban fishing (at present, 11 days) and no-fishing zone as sanctuaries (at present 5 areas). Under this rules, recently the size of Jatka was extended to 10 inch or 25 cms. In 2014, the amendment was made on thefate of seized fishes as can be distributed free to the poor. Even any auction money will be deposited to the government account. Total dewatering of any waterbody is prohibited. Import, breed, culture and sell of exotic African catfishClariasgariepinus was prohibited. The minimum size mentioned in the second schedule was replaced with larger size for carps, hilsa, pangus, boaletc fishes.

The Fish hatchery Act (2010) and Regulation (2011) has prohibited hybridization or inbreeding of fishes. It also prohibit to import fish or its eggs, larvae and spawn without the prior permission of the fisheries department.
The National Shrimp Policy was gazetted in 18th August 2014. Here it delivers its concern on the social-environmental aspects, conservation of natural habitat of the shrimp, and land and shrimp culture area zoning among fifteen sub area it covers.

Department of Fisheries (DoF) activities in fish and fisheries resources management

For fisheries resources management and conservation the DoF at present is conducting the following activities (DoF, 2014).

Hilsa Shad Fishery Management: The national fishHilsais an important diadromous fish in Bangladesh. The fishalone contributes more than 11% of the country production and has impact on the national economy, employment and export. In 2012-13 Hilsa production was 3.51 lakh MT, of which the cash value was more than10, 000 crore taka. DoF has taken some steps to strengthen the on-going Hilsa management through jatka Conservation Program like establishing five Hilsa sanctuaries, arranging need based training to involve the Hilsa fishers for alternation income generating activities, and supporting the hilsa fishers with 40 kg food grains/family/month during the ban periods for four months.

Protection of Natural Breeding Ground of Haldariver: DoF is protecting the natural breeding habitats of the Halda river to protect natural breeding ground of Indian Major Carps. In 2012 the total natural collected spawn/hatchling was 1569kg.
Integrated Natural Resource Management: DoF is implementing integrated natural resource management system by local users contributors to conserving the biodiversity and livelihoods in the selected wetlands and floodplains in the Padma-Jumna rivers delta region through a development project.

Fish Habitat Restoration: In 2011-12 total 970 water bodies (areas about 2,123ha) have been developed by 07 development projects under DoF. As a result additional 3,000 MT fish will be produced annually. In addition 450 hectare ModhumotiBaor has been excavated mechanically in the same fiscal year. About 60 ha Hurasagarriverwas re-excavated in the 2012-13 fiscal years(DoF, 2014).

Involvement of different governmental and non-governmental agencies

There are at least 14 ministries and more than 25 governmental departments and institutes are directly or indirectly involved in aquatic sectormanagement in Bangladesh (Ahmed and Hossain, 1997). In addition several national and international agencies are nurturing the sector with their own agendas. Considering these some of the policy documents relevance to the fisheries conservation issues can be reflected in the plans from other agencies. However, many of the laws from other governmental agencies have direct influence on the fisheries but in major cases show noreverence for aquatic bio-resources. Some of them are discussed below.

The Canal Act 1864: An Act and law relating to the collection of tolls on canals and other lines of navigation, and for the

construction and improvement of lines of navigation in Bangladesh. According to this Act, the Government from time to time, by notification published in the official Gazette, to declare any navigable channel specified by notification. No conservation related rules included in this act.

The Inland Shipping Ordinance, 1976: The ordinance providing survey, registration and control of navigation of vessels plying on inland waters. In chapter 5A, explains the protection of inland water from pollution. This prohibited polluting water from sewage, oil and oil mixture rom vessels. A provision of pollution prevention certificates can be obtained from the Navigation authorities under Inland Shipping (Amendment) Act, 2005. However, no such precaution is observed from the vessels operating our waters.

River Protection Act 2013: This act is put forward to safeguard river from pouching, water pollution, industrial waste disposal, river flow restoration etc. A commission was formed very recently in September 2014 to conduct this activities under shipping ministry. The activities of this commission cannot be judged in such a short time. There is no provision of fisheries or aquatic resources manager as a member of the commission. Thus the proper address for bio-resource management is in question.

Jalmohal management rules 2009 (proposed): This rules though considers to include the fishers community and fishermen society to lease particular waterbody or portion of river. This rulecan only be used as revenue earningtools but not to manage aquatic resources. As the lease holderswere found to be accomplish maximum benefit fromthe water area rather than protecting or conserving its biological quality. So far, the present policy is still detrimental for the bio-resources management in the Jalmohal.

Other laws of the land like the Forest Act, 1927 (MoEF), Environment Policy and Implementation Plan (MoEF 1992), Livestock Development Policy (MoFL 1992), National Tourism Policy (MoCA&T, 1992), National Forestry Policy (MoEF, 1994), National Energy Policy (MoEP&MR, 1996), New Agricultural Extension Policy (MoA, 1996), National Women Development Policy (1997), National Policy for Safe Water Supply and Sanitation (MoLGRD&C 1998), National Agricultural Policy (MoA ,1999), Industrial Policy (MoI, 1999), National Water Policy (MoWR ,1999a), National Shipping Policy (MoS, 2000), National Rural Development Policy (MoLGRD&C 2001) and National Land Use Policy (MoL, 2001), Wildlife (Conservation and Security) Act, 2012 (MoEF) have direct or indirect impact on aquatic resources management but merely addressed fisheries.

Disengagements of fisheries conservation actions

The department of fisheries is working with some definitive rules and regulations for conserving the fish and fisheries resources in Bangladesh. Previously IUCN, Bangladesh has noted fifty four species of fishes in various categories of declining or on the verge of vanishing status (IUCN-B, 2000). Preservation of fishes like other animals are important, not only because many of these species are beautiful but can provide economic benefits. The environmental policy can comply with the pollution preventing plans but do not have alignment with fisheries, forest or navigation department in action. The recent oil spill from a tanker in the Sunderbans is an example. The tourism policy or forest rules could match ecotourism but not preventing damage to the aquatic system in their jurisdiction. Pollution form the power sector, industry and agriculture have ignored the impact on the aquatic resources instead. Rural development policy, land used policy, wetland policy do not demark land and wetland uses. The prevention of urbanization trend by invading wetlands cannot be executed in real life scenario in rural Bangladesh. One of the example is the rule employed from the court preventing law enforcer to stop production illegal nets in Bangladesh. There is no sanctuary laws and policy for the fish. Besides temporary protection for certain fishes could be done by establishing ‘fish-refuge’. Aquaculturist and fish aquarium traders are regularly shippingfish from different foreign countries. There are no quarantine policies and facilities in Bangladesh. Illegal exotic/alien fishes or diseased fishes could enter the country to create devastation in the sector. There is no fisheries management activities of department of fisheries inside the forest.

Thus conservation of fish bio-diversity in Bangladesh is hampered for various engagements of policies or laws. Interdepartmental integrated approach could aids in conservation of fish and fisheries resources of Bangladesh.

Way forward

In Bangladesh, good number of scientists, technocrats and other personnel are involved in research, education, technology development and administration in fisheries of Bangladesh. The policy initiatives are required not only for making fisheries sustainable and responsible, but also globally compatible so that Bangladesh fisheries stand to gain in international conservation standard. This arrangement was appropriate until recently considering that only the selective resources are harvested. The global scenario with respect to fisheries is rapidly changing with major developments in

aquaculture. Production, harvesting and processing technology can be expands for local and global markets for fish and fishery products and saving the others. Fishing policies of the government should be revised from time to time. Accordingly the governmental agencies of Bangladesh subsequently encouraged to start dialogues with other relevant ministries in order to gather inputs on the bio-resources management and conservation of the vulnerable fishes and addressing issues relating to the various stakeholder groups etc.

The fishing policy announced by the Govt. of Bangladesh in the past focused only on the developmental needs of the sector, leaving aside issues pertaining to the conservation and management of the sector. Even though substantial efforts weresometimes mishandled through political or local influences due to non-existence of an integrated policy for this sector and was found to be hampering fulfillment of the conservationgoals. Therefore in the present policy needs to bring the traditional and occasional fishermen in to the focus together with other stakeholders in the sector so as to achieve harmonized development of the fishery and the conservation of the sector to reach the benefits to all. An integrated fishery policy should be in place with focus on(1) to enhanceculture fish production of the country up to the sustainable level in a responsible manner so that per capita fish protein intake of the people maintained and the boost of export from the country increase, (2) to ensure socio-economic security of the fishermen whose livelihood solely depends on fisheries (3) to ensure sustainable development of fisheries with due respect for the ecological integrity and bio–diversity.The policy therefore needs to be blended towards the need for aquaculture product and selective restriction from the access to the major open waters besides putting in place strict management regimes. Promoting exploitation of the Bay of Bengal and coastal waters for reducing pressure in the traditional open water fishing areas.

Recommendations

In view of the above the following recommendations are made for the management and conservation of fish and fisheries resources of Bangladesh.

1. Fisheries department should have strong extension department to aware people on fish conservation and the benefits.
2. There should be 'Fish Sanctuary Acts and rules' in the country
3. Introduction of the 'Fish Refuge' acts and rules in the country
4. Establishment of 'Fish quarantine acts, rules' and facilities in the country.
5. Wetland policy of Ministry of Lands should be revised for biological management with community involvement.
6. Fish habitat restoration approach should be included in the Jalmohal, River protection and canal act.
7. Community based conservation hub should be introduced in the country, so that selected wetlands should be protected for endangered species. Media should be involved to inspire other communities to protect their natural resources including rare or endangered fish species.
8. Alternative livelihoods for the fishers could prevent fishing in the restricted area.
9. Aquatic pollution control is must. The relevant acts and rules should be incorporated for the benefit of the aquatic resources.
10. Navigation of motorized boats and vessels should be restricted to avoid migratory routes, spawning and nursing grounds of fish and other aquatic animals.

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Community based conservation: Baikka Beel

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Background

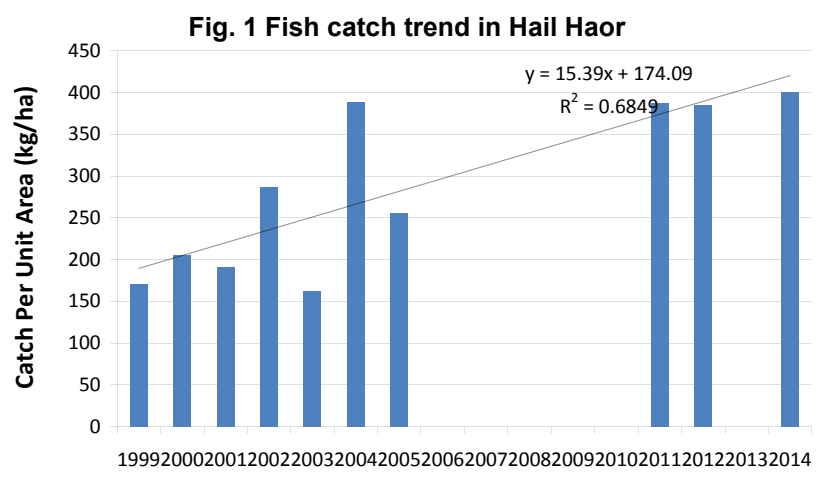
In Bangladesh most conservation initiatives have involved formal protected areas managed by government, or more recently through collaborative or co-management in keeping with international trends. This paper summarises a unique case where community actions in a co-management framework have restored biodiversity in a wetland sanctuary. Hail Haor is a large wetland with a dry season water extent of about 3,000 hectare (ha) and monsoon water extent of over 12,000 ha, 6 km northwest of Srimongal in Moulvi Bazar District, north-east Bangladesh (24° 23 N, 91° 44 E). Once rich in fish and biodiversity - "From horizon to horizon the sky was full of wheeling ducks and their clamorous voices could be clearly heard for half a mile" (Mountfort, 1969) by 1992 monthly surveys of Hail Haor revealed few migratory ducks (Flood Action Plan 6 1993) in the over-fished haor. From 1999 under a USAID supported project, local communities reached agreement on the potential for a large sanctuary, with the primary aim of restoring fisheries (MACH, 2007). Support from each tier of government was gradually obtained, resulting in the Ministry of Land setting aside about 170 ha of "Baikka Beel" as a permanent sanctuary in July 2003. In parallel a community organization - Baragangina Resource Management Organization (RMO) - had been developed so that it could protect this sanctuary. Since then it has had continued support for conservation through a series of projects funded by USAID.

Conservation measures

The RMO quickly stopped fishing and hunting in the sanctuary, with support from local government, and employed local guards, initially with grants and later with a regular allocation from an endowment fund. A management plan for the sanctuary (which ended all extractive use and added visitor arrangements) was developed through participatory planning sessions and workshops with local resource users and stakeholders, and finally approved by the co-management body – the Upazila Fisheries Committee - in 2006. From 2003 to 2006 habitat restoration was funded. Local contractors innovated small scale dredgers to deepen just over 3 ha of silted up beel, and most years since modest areas have been re-excavated by hand. Here submerged concrete hexapods and pipes were placed to shelter fish, as a deterrent to fishing and to provide substrate for periphyton growth. Also over 11,000 koroch (*Millettia pinnata, syn. Pongamia pinnata*) and hijal (*Barringtonia acutangula*) swamp trees were planted. These have developed into a swamp woodland strip along one site of the sanctuary flanked by bushy swamp thicket dominated by dhol kolmi Ipomoea fistulosa.

Impacts

Although it protects many species from plants to mammals such as Fishing Cat *Prionailurus viverrinus*; the primary aim of the sanctuary was to protect native fish in the dry season so that they could reproduce and spread into the rest of the haor in the monsoon. As no fishing is allowed in the sanctuary, impacts can only be assessed from the rest of Hail Haor, and are also affected by other factors. Compared with 1999 baseline condition, fish catches have roughly doubled (Fig. 1). The 2010, 2011, 2013-14 catch per unit area (over 370 kg/ha) is close to the maximum considered sustainable for a healthy floodplain wetland ecosystem. Based on a wet season water area of 12,490 ha and regular intensive monitoring, the added production of fish amounts to about 2,600 tons a year in Hail Haor.



Fish diversity has also increased to some extent from about 70 species a year in 1999-2001 to over 80 species

a year since 2010. But a recent concern is a substantial catch of Grass Carp, which was rarely caught in the base and early years, these have presumably escaped from the rapidly expanding areas of aquaculture encroaching into the haor floodplains. This has reduced the areas of seasonal open water fishery available to traditional small scale fishers.

The sanctuary has proven how community protection and solidarity to resist pressures such as hunting could quickly restore waterbirds. Wintering waterbirds increased from barely 300 of 16 species in 2004 to annual peaks of 9,000 or more of typically 40 species from 2009 onwards. Based on Wetlands International (2007) the site has held up to 9% of the flyway population of Fulvous Whistling-duck *Dendrocygna bicolour*. Numbers of long distance migrants and locally resident birds have also increased, for example Purple Swamphen *Porphyrio porphyrio* rising from 30 to over 1,000. Globally threatened species have also returned: up to 12 Pallas's Fish-eagle *Haliaeetus leucoryphus* and up to four Greater Spotted Eagle *Clanga clanga* (both Vulnerable) now spend the winter here. Variations in numbers over the dry season and between years reflect to some extent environmental conditions (such as water levels).

Fig. 2 Baikka Beel mid-winter waterbird census

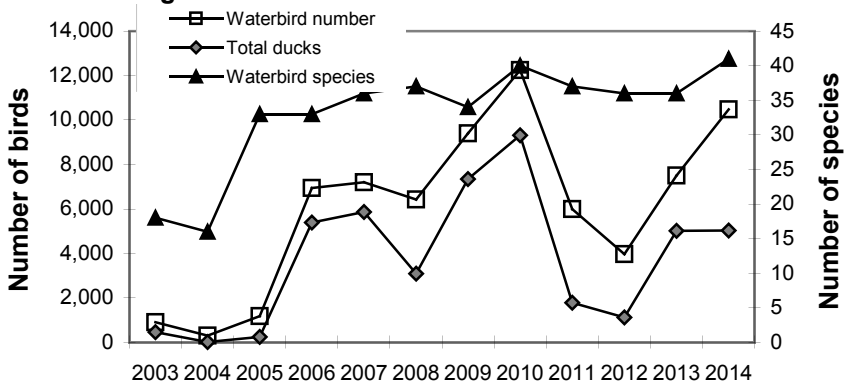
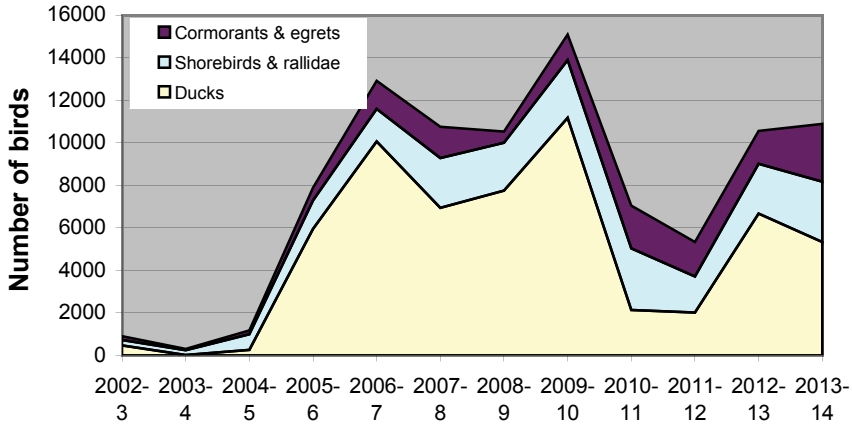


Fig. 3. Annual maximum waterbird counts in Baikka Beel



By now 180 bird species have been recorded in this relatively small area, of these 107 are migrants, 68 are waterbirds, and 12 are globally threatened or near-threatened.

A nest box scheme since 2006 has enabled declining Cotton Pygmy-goose *Nettapus coromandelianus* to breed in Baikka Beel. This is the only such successful nest box scheme in the wild for this species anywhere in the world. In 2011 21 new boxes of different sizes were erected on concrete posts among the trees. In 2011 12 boxes were used, 10 by pygmy-geese, and in 2012 out of 15 boxes (six were stolen) seven boxes were used, six by pygmy-geese, with multiple females laying in some boxes resulting in clutches of up to 30 eggs.

Protection and recovery of marshy bushy vegetation has restored an important habitat for migratory passerines. Since 2011 mist-netting studies undertaken by Bangladesh bird club with the Wetland Trust in the dhol kolmi have revealed several rare and skulking species including regular White-tailed Rubythroat *Luscinia pectoralis*, large numbers of Pallas's Grasshopper-warbler *Locustella certhiola* (28 caught in 6 days in 2013), 13 species new to the sanctuary, and of these four species new to Bangladesh. In December 2011 the little known Large-billed Reed Warbler *Acrocephalus orinus* was caught and released (the first undoubted record in South Asia for 78 years) (Round et al. in press).

Domestic and foreign visitors have been attracted by waterbirds, a wetland full of lotus blooms in the summer and monsoon, and relatively easy access. In response from 2006 onwards visitor facilities were developed: an observation tower, a visitor centre, and a smaller observation platform with information centre, and members of the RMO were trained in guiding visitors on land and by boat. Modest entrance fees go towards maintenance costs.

Conclusions and Lessons

In effect Baikka Beel is the only community managed nature reserve in Bangladesh, and demonstrates how rapidly wetlands can recover their biodiversity value. However, sustaining this success faces several challenges. Increasingly large areas of the haor wetland near to the sanctuary have been enclosed for aquaculture businesses, excluding traditional fishing and thereby increasing pressure on Baikka Beel sanctuary. Notably in April 2013, unusually low water levels, natural fish deaths, and influences seeking to undermine the sanctuary resulted in a mass fish-poaching event within the sanctuary, in which over 1,000 people participated. Awarenssess campaigns by the RMO and support from the government administration and law enforcement agencies have helped prevent this being repeated.

Key lessons are: the need to develop and maintain support from a wide range of local stakeholders, importance of sustainable funding (in this case from an endowment fund), maintaining a focus on conservation that brings benefits and local pride, and resisting continued threats such as aquaculture conversion in surrounding wetland areas.

Acknowledgements

I thank all members of Baragangina RMO for protecting Baikka Beel sanctuary and making it a success; the many past and present colleagues in MACH and CREL projects who have helped in this and shared data; the many birdwatchers who have shared sightings; and Bangladesh bird club, Phil Round and Nick Dymond for sharing details of birds ringed.

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Theme 2: Abstracts

Species & Habitat Protection:
Necessity of Science based Policy and Governance

Fish sanctuary and diversity of fishes at the old Brahmaputra River

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Abstract
A study was carried out to know fish diversity of the old Brahmaputra adjacent to the Bangladesh Agricultural University and the impact of the sanctuary on the diversity of fish and other aquatic organisms that was established in the old Brahmaputra river in December, 2012 and continued up to May, 2014. A total of twenty-nine fish species in 2013 and thirty-four fish species in 2014 were recorded inside the sanctuary over the experimental period. The fishes under the groups- barb, minnows, and parch were most abundant followed by catfish, eel and needle fishes. Average weight and number of fishes were recorded and an increasing trend was observed. This indicated the presence of food organisms and suitable habitat for foraging and breeding inside the sanctuary. A number of endangered and critically endangered fishes (IUCNB, 2000) were also observed in the sanctuary during the experimental period. Six different types of non-fish aquatic organisms were also recorded. From the present study, it could be concluded that the diversity of fish and other aquatic organisms increased in the river old Brahmaputra due to the setting up of the sanctuary. It is therefore recommended that fish sanctuary is an important fish management tool which can help to conserve the biodiversity of the fish and other aquatic organisms through proper management.

Wetland biodiversity conservation in Bangladesh: potentials, policy and political imperatives

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Abstract
Major wetlands in the country are owned by the state and designated as jolmohals or water estates and access by the people is restricted by state policies. The policy allows only the registered fishers' cooperatives to have access of fishing through leasing for short to medium terms which currently ranges from three to six years. Although it is mentioned that the leasing policy aims primarily at conserving and enhancing fisheries productivity, wetland biodiversity and poverty reduction, in reality there has been hardly any practice of management intervention that contributes to achieving conservation and enhancements of biodiversity as well as benefiting the poor fishers. As such, the conventional state-driven wetland management policy can simply be termed as "lease management" rather "resource management". Besides, there has been no effective enforcement of fish acts and monitoring of management practices being undertaken by the leaseholders. By contrast, the history and practice of project-based co-management of wetlands and biodiversity in multiple geo-spatial settings of the country by now reached over two decades and yielded encouraging results in terms of increased productivity and biodiversity including positive livelihood outcomes of poorer communities. While the place-based communities at project sites collectively plan, implement, observe and access benefits, sustainability of co-management practices beyond project often gets stumbled mainly due to policy and political constraints. This paper has three objectives. First, it describes gaps in current leasing policy and processes with respect to conservation and management of wetland biodiversity. Second, approaches and results of some wetland co-management projects in Bangladesh with few examples of policy and political imperatives that affect sustainability co-management systems. Finally, it concludes by suggesting conduits to facilitate sustainable co-management of wetlands and biodiversity in Bangladesh.

Butterfly Fair: Awareness for Butterflies and its habitat conservation in Bangladesh

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Butterflies play an important role in the ecosystem as pollinators. Environmental variables, most notably climatic factors, are most often correlated with species abundance and diversity. Therefore vegetation damage, commercial logging, human settlement or any other destructive activities in the habitat should be stooped. 'Butterfly Fair' is the pedestrian for conservation and awareness initiative in this endeavor. In a nutshell of the overall objective this carnival likely - create much awareness about this insect who works at climate indicator, to know and expedite the research work and contribution in butterfly research arena, share the country index of butterflies of Bangladesh, Identification of new taxon, explore the threaten taxon across the country along with disseminate of its threat and to know and explore required conservation approach and outreach program .This is an educational and conservation awareness approach for young generation as well as school children to adolescent along with the academicians and researchers. A day long awareness program has been conducted at Jahangirnagar University with highlighting couple of integrated components -. Butterfly award for those who/whom contributes thorough Butterfly/Zoological research, Book publication on butterfly is also unveils each year program, School children drawing competition take place each year under two categories, Photography exhibition held with the participation of photographers (home and abroad), Frame display held across the event area where appx 175 frames had been exhibit, Live butterfly display conducted each year inside the confine netting area in order to observe their beauty and biological activities, Butterfly imitation also featured by the children, Documentary showcase has been displayed on the taxon to conserve and create environmental awareness, Kite flying is another eye catcher event with the shape of various butterfly also displayed in the event, Debate competition on 'Butterfly and Nature' as well as a prize giving ceremony also held to make this awareness event more attractive and fruitful. The fair has been continued since 2010. In each fair, thousands of people had been participated. Country's most reputed print and electronic media covered this event with immense enthusiasm for butterfly and its habitat conservation. Literally the fair become centre place for learning, practicing and creating awareness for this beautiful creature across the country.

Managing coastal islands for food security and livelihood earning

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The coastal resources of Bangladesh have been exploited extensively since long without understanding the basic functional ecological systems. The management of these resources is also very limited. For this reason a segment of the central part of the coast of Bangladesh was studied at the Char Tamuruddin of Hatia Upazilla, Noakhali District to calculate the stocking rate for suggesting the management policy of coastal islands of Bangladesh. The area of the island was 6.904 sq. km. Ten 1m × 1m quadrats were established in each sampling occasion at different places throughout the char and fresh weight were measured of key forage species (Uri-grass) to estimate the production since December 22, 2010 to March 2013. Net primary production (NPP) was measured by the following formula NPP = B + L + G. The annual primary production of Uri-grass was found to be 3,000 tons per year. The "rule of thumb" i.e. "take 50 leave 50" was used to determine allowable levels of utilization. Forage demand for the target species (here spotted deer is considered) to be about 328.5 kg/y and 474.5 kg/y for female and male respectively. These values show that if we plan to have only female in the herd then the number will be 4566 and if only male is used then the number will be 3161. In western ranches, usually 2 bulls are maintained per 20 oxen. If we take this into consideration then the studied island can support 4110 female and 456 male deer. If we consider a more simpler and conservative procedure that allocated 25% of current year forage production to livestock, another 25% to natural disappearance and 50% is left, the number of deer will be half. This will help to maximize the utilization of the natural resources of the study area without any harm that will help us by mitigating the natural calamities due to climate changes and saves lives and millions of dollar. The knowledge gained from this study can also be scaled up to help manage other similar coastal islands. Deer can be used as sacrificing animals during the Eid-Ul-Azha festival and meat can be sold in local market. Local community should be given the ownership of the chars to manage the resources to earn their livelihood and the resources will thus be better managed.

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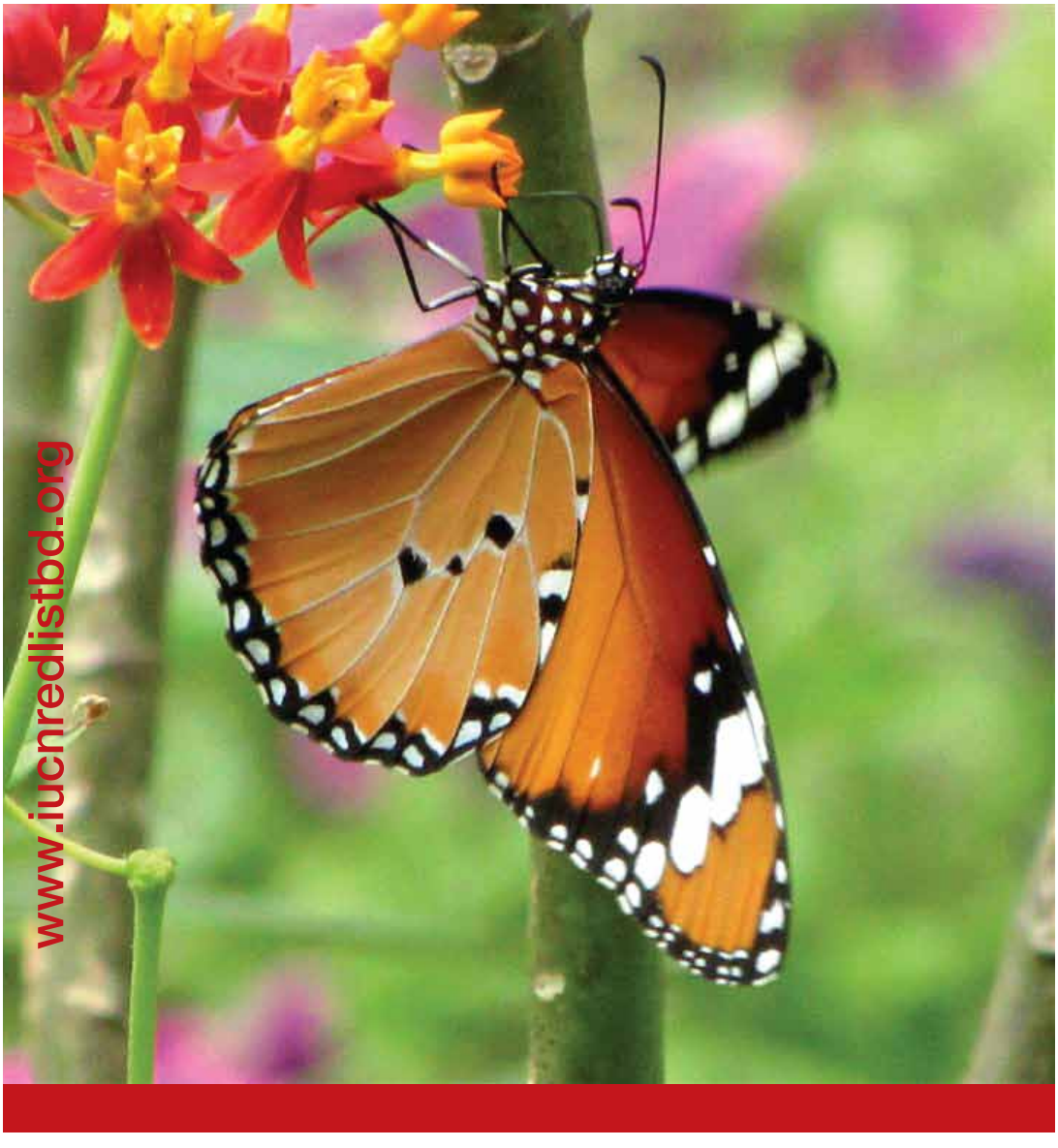

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