Biological Diversity of Swatch-of-No-Ground, Bay of Bengal, Bangladesh

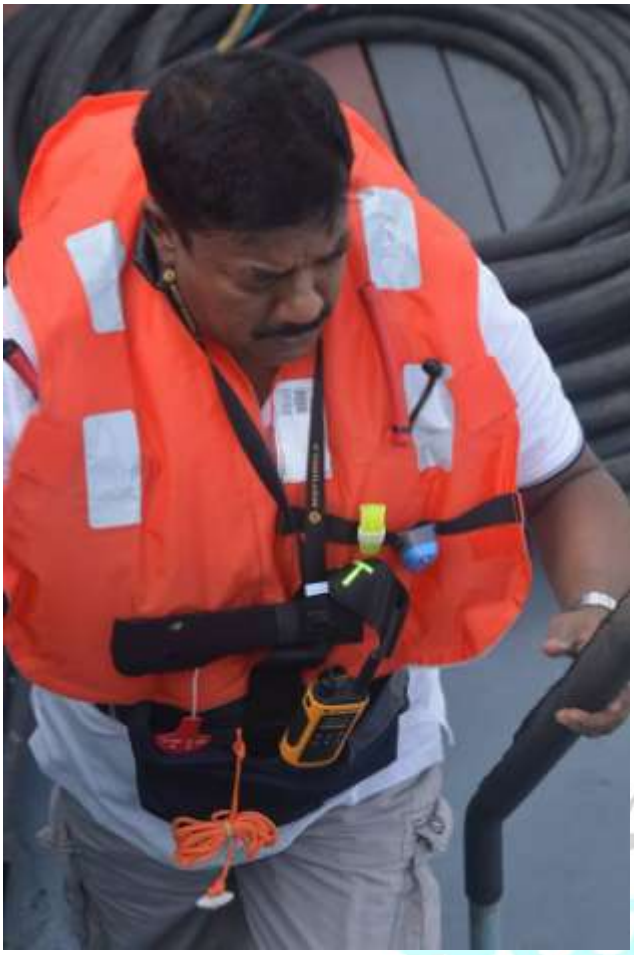
A snapshot

Mohammed Anisuzzaman Khan

Fellow: Ashoka Innovators for the Public

1. Introduction and background

This is first preliminary observation report of a series of three expeditions carried out in the Bay of Bengal by Isabela Foundation to learn the present state marine biota at Swatch of No Ground (SoNG). The expeditions was organized jointly by Ministry of Fisheries and Livestock and Isabela Foundation in collaboration with Bangladesh Navy during 2017 and 2018. All three expeditions was led by Mr. Kabir Bin Anwar, Chairperson Isablela Foundation and participated by scientists from University of Chittagong, Bangladesh River Research Institute, members of Prime Minister's Office and member's of Isablela Foundation.



Mr. Kabir Bin Anwar, Team Leader of Isabela expedtions at SoNG

World's second largest hole is found in Bay of Bengal, **Swatch of no Ground** a trough-shaped marine valley or canyon that cross the continental shelf diagonally and situated on the south of the Ganges-Brahmaputra delta. It is also known as Ganga Trough.

Secondary information of various sources revealed that Similar delta-front troughs are found off the mouth of the Indus River known as Indus Trough and off the West Side of the Mississipi delta, the Mississipi Trough. Swatch of no Ground has a comparatively flat floor 5 to 10 km wide and walls of about 12' inclination. At the edge of the shelf, depths in the trough is about 1,200m. It has been suggested that the Swatch of no Ground has a seaward continuation for almost 2,000 km down the Bay of Bengal in the form of fan valleys with levees.

The sandbars and ridges near the mouth of the Ganga-Brahmaputra delta pointing toward the Swatch of no Ground indicate that sediments are tunneled through this trough into the deeper part of the Bay of Bengal. Slumps, growth faults and evidence of mass movement coupled with high sedimentation rates near the Swatch of no Ground provide dramatic evidence that modern sediment is being channeled off-shelf through the submarine canyon to the Bengal Fan.

Studies on the Bengal deep sea fansuggest that Swatch of no Ground is feeding the Bengal Fan by turbidity currents. Most of the sediment of the Bengal Deep Sea Fan has been derived from the confluent of Ganges and Brahmaputra rivers, which drain the south and north slopes of the Himalayan, respectively. Under the present condition perhaps low-density turbidity currents and sand cascading are perhaps dominating process of sediment transport from the shelf to the deep sea through the Swatch of no Ground.

There is some controversy regarding the origin of Swatch of no Ground. However, it is generally believed that during the Pleistocene (2-0.1million years ago) lower sea level, Ganga-Brahmaputra River was discharging its sediment load directly on the shelf edge. Combination effect of river flow and turbidity currents generated at the shelf break and upper slope was responsible for the formation of the Swatch of no Ground. Evidence from the Bengal Deep-Sea Fan also tends to support this view. It has been observed that turbidity currents during the Pleistocene lower sea level dominated sedimentation on the Bengal Deep-Sea Fan and the sediments were distributed on the fan by a system submarine channel originating from the Swatch of no Ground.

Swatch-of-No- Ground (SoNG) a mysterious sub-marine canyon in the Bay of Bengal which is geologically, hydrologically and ecologically a less studied marine ecosystem on earth.

Some preliminary information of the area storied mainly by the sailors of olden days which portrayed as hearsay and myths pertaining to it's depth, water current and sightings of mega fauna like Whales, Dolphins, Porpoises, Sharks, Fish and Turtles .
The area mapped by the shippers and sailors as an important corridor navigational route between Asia and Pacific during pre-historic era.

Very recently, Bangladesh Navy conducted a hydrological mapping of the area to learn about the depths, currents and hydro-morphology of the canyon and some wildlife researchersfrom IUCN/SSC/Cetacean Specialist group with support of Whale and Dolphin Conservation Society (WDCS) UK.and Wildlife Conservation Society (WCS) USA. visited the place and reported sightings of marine mammals and some seabirds of the area.

Based on the preliminary study and findings on the marine mammals species richness a part of SoNG had declared as Marine Protected Area (MPA) by the MoEF under the Wildlife (Conservation and Security) Act 2012. in 2014. MOEF and UNDP is in the process of developing a project for studying and managing the MPA at SoNG.

Mr.Kabir Bin Anwar Director General, administration of the Prime Minister's Office (PMO) Bangladesh with his personal inquisitiveness and interest on SoNG organized RECOs under the banner of Isabela Foundation (IF) with support from MoFL and Bangladesh Navy.

The present note reviewed the secondary information available on the subject and jotted the preliminary findings of the expedition. This occasional paper describes the dire need of a long term management strategy to conserve marine biodiversity; a strategy incorporating impacts on habitat, and the biological, social and economic

factors of fishing. It also propose new management tools including knowing ,learning marine biodiversity and using sustainably the biological resources and finally guiding MPA management regime to maintain marine biodiversity and sustain fisheries.

The total number of marine species in the regions, and globally, is still uncertain because so many species remain to be sampled, distinguished, identified and described. An estimated 25%–80% of species remained to be described in Australia, Japan, Mediterranean deep-sea, New Zealand, and South Africa, also regions of high species richness. We may expect the proportion of undescribed species to be toward the higher end of this range for the tropics of Asia and the Pacific. Thus, the proportion of undiscovered species may be close to 70%–80% of all marine species. The current estimate of described species is 230,000 suggesting there may be 1 million to 1.4 million marine species living on Earth.

Marine Biological diversity of Bangladesh is not yet inventoried and waiting lots of discoveries as far as it Ichthyofauna, Herpetofauna, Avifauna and invertebrates are concerned. Some sporadic survey carried out by BOB/FAO and BLOMBE programme to understand the species diversity and stock of marine fish. A preliminary checklist of marine mollusks and shell fish is available. But the occurrence, distribution and abundance invertebrate fauna is still remain unexplored.

2. Goal and Objectives

"Quest for Sea and Life"- Towards non-fish marine biota data base of Bangladesh and initiative in Inventorying Marine Biodiversity of Bangladesh Using Meen Sandhani

Objectives

1. To get practical idea about marine biota of Bangladesh at BoB
2. Collect updated information on the marine biodiversity of BoB-B and adjacent area
3 .To trial the feasibility of underwater diving by the professional scuba divers
4. To document the elements (Photography) of aquatic marine life
5. To understand the ongoing uses like fishing and navigation in the area
6 .To orient inter-disciplinary researchers and provide on-job training for making the team suited for future research and sustainability
7 .Need assessment of logistics, research equipment, safety devices and underwater exploration methodology to carry out comprehensive research and management planning of MPA
8. Analyzing stakeholders/parties to be engaged in managing MPA
9. Identification of priority action-research needs and monitoring indicators
10 .Learning about the Trans-boundary networking in MPA management (ICTPs)

11. Prepare recommendation and disseminate to the relevant stakeholders (MOEF, Bangladesh NAVY, BFD, Ministry of Fisheries and Animal Resources and Ministry of Defense, etc.)
12. To get idea and prepare sustainable use of the marine about marine fishery

Action Plan

- Team Building and Coordination network among all stakeholders
- Comprehensive literature review to establish a baseline and benchmark
- Inception Workshop on Methodology Finalization and Work planning
- Orientation and familiarization about QfSL and Meen Sandhani- the research ship
- Trial cruise and sample plot and route mapping for survey
- Underwater diving trial will be conducted at nearshore of Saint Martin's island.
- The QfSl survey will start from Saint Martin's island and will follow the routes and sampling plots all along the coast, on shore, offshore to SoNG
- Metrological and navigational protocol
- Health, Safety and Security protocol
- Coordination ,Communication and Rescue Protocol
- Collection of data, processing and archiving on board for data bank
- Collection of sample specimen, preservation and storing as per taxonomic and Taxidermi protocol
- Photographing documentation both still and video
- On-board meeting and workshop
- Identification and recording hindrances and other problems faced
- Emergency response protocol
- Monitoring, Supervision and Reporting
-

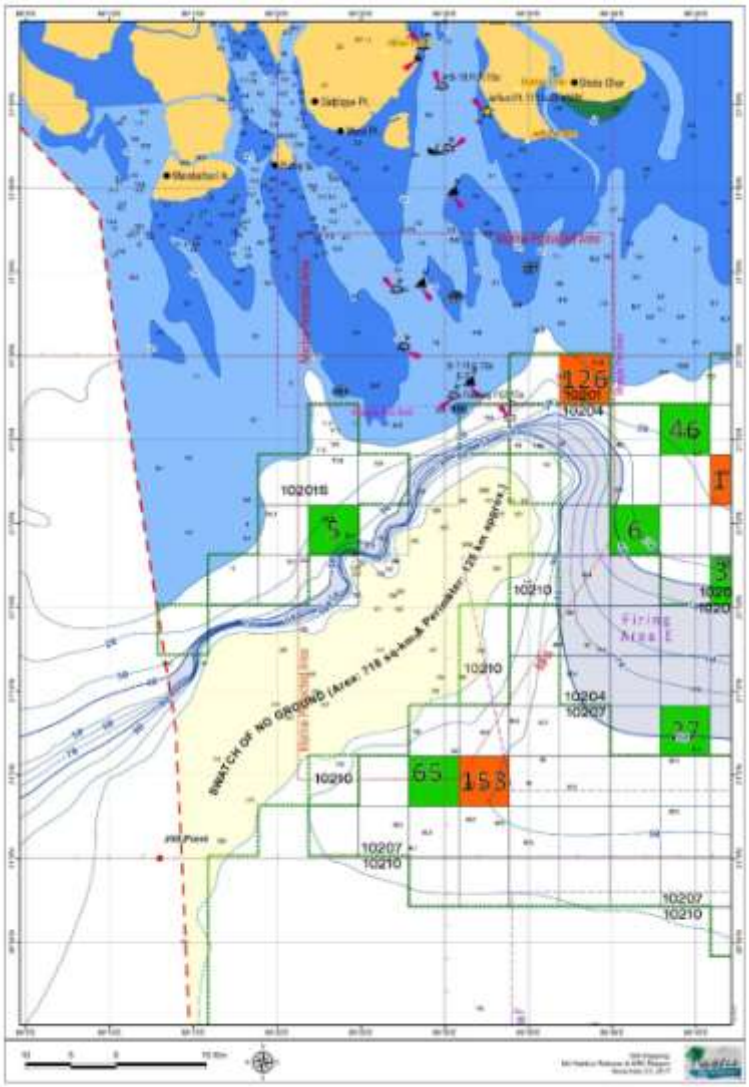
Research Team (List of Key personnel annexed as II)

1. Team Leader
2. Principal Investigator
3. Marine Ecologist
4. Marine Invertebrate Specialist
5. Marine Herpetologist
6. Marine Ornithologist
7. Marine Mammologist
8. Coral Taxonomist
9. Marine Botanist
10. Marine Dive Specialist
11. GIS specialist
12. Filed Biologists/marine scouts

13. Data Manager
14. Photography and video documentary team
15. Taxidermist
16. Data Compiler
17. Water Quality Specialist

3. Study Area

Swatch- of- no- Ground a trough-shaped marine valley or canyon that cross the continental shelf diagonally and situated on the south of the Ganges-Brahmaputra delta.



The Bengal Fan, also known as the Ganges Fan, is the largest submarine fan on Earth. The fan is about 3,000 km (1,900 mi) long, 1,430 km (890 mi) wide with a maximum thickness of 16.5 km (10.3 mi).[1] The fan resulted from the uplift and erosion of the Himalayas and the Tibetan Plateau produced by the collision between the Indian Plate and the Eurasian Plate. Most of the sediment is supplied by the Ganges and Brahmaputra rivers which supply the Lower Meghna delta in Bangladesh and the Hoogly estuary in West Bengal (India). Several other large rivers in Bangladesh and India provide smaller contributions.[2] Turbidity currents have transported the sediment through a series of submarine canyons, some of which are more than 1,500 miles (2,414 km) in length, to be deposited in the Bay of Bengal up to 30 degrees latitude from where it began. To date, the oldest sediments recovered from the Bengal fan are from Early Miocene age.[3] Their mineralogical and geochemical characteristics allow to identify their Himalayan origin and demonstrate that the Himalaya was already a major mountain range 20 million years ago.[4]

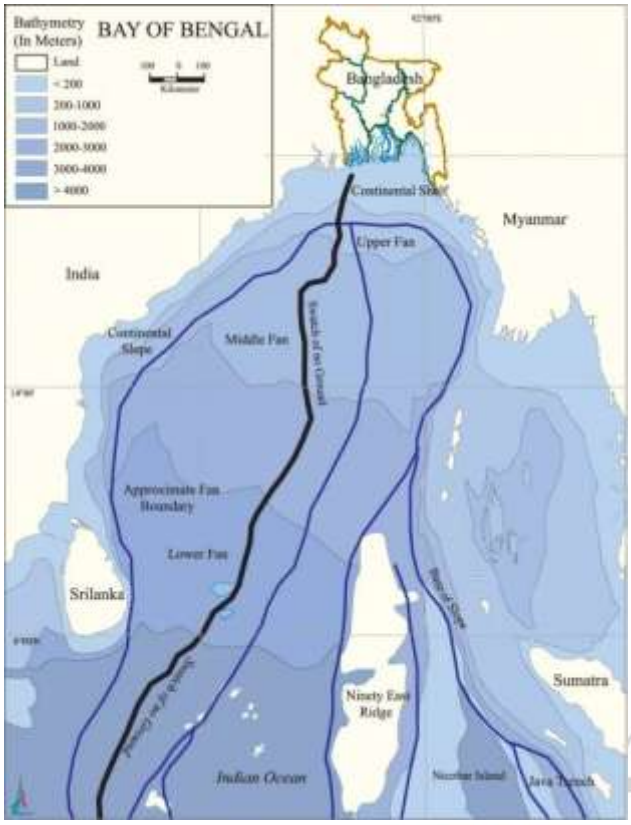
The fan completely covers the floor of the Bay of Bengal.[5] It is bordered to the west by the continental slope of eastern India, to the north by the continental slope of Bangladesh and to east by the northern part of Sunda Trench off Myanmar and the Andaman Islands, the accretionary wedge associated with subduction of the Indo-Australian Plate beneath the Sunda Plate and continues along the west side of the Ninety East Ridge.[5][6] The Nicobar Fan, another lobe of the fan, lies east of the Ninety East Ridge.[6]

The fan is now being explored as a possible source of fossil fuels for the surrounding developing nations. The fan was first identified by bathymetric survey in the sixties by Bruce C. Heezen and Marie Tharp which identified the abyssal cone and canyon structures. It was delineated and named by Joseph Curray and David Moore following a geological and geophysical survey in 1968.[6][7]

A deep sea canyon called Swatch of no Ground is located south of Sundarbans National Park and the island of Dublar Char. This area hosts important habitats for cetaceans including endangered species such as various dolphins, Irrawaddy dolphins, and Bryde's whales.

The Swatch of No Ground is a shelf canyon that deeply incises the Bengal shelf near the Ganges–Brahmaputra river mouth, cuts the foreset beds of the subaqueous river delta and acts as temporary depocenter between river mouth and Bengal fan.

Sedimentation rates in the Swatch of No Ground are highest near the canyon head at ~50 cm a−1, decreasing to ~15 cm a−1 in 600 m water depth. The canyon deposits consist of intercalated fine (silt–clay) and coarse (silt–sand) grained deposits. In seismic profiles, small-scale sedimentary structures and parallel-bedded layers reveal that sediment in the canyon is mainly deposited from suspension. During fair weather conditions tidal currents are the dominant mechanism that transports plumes of suspended river load towards the canyon, forming fine-grained silt–clay layers. During storm conditions, sediment is resuspended on the inner shelf and subaqueous delta east of the canyon. Storm-generated bottom currents transport the resuspended sediment alongshelf to the canyon where the particles are trapped and form graded coarse silt–sand layers.Channels and gullies in the Swatch of No Ground indicate active gravity-driven currents with an erosional character in the upper canyon and non-depositional character below ~450 m, suggesting that persistent or ephemeral currents presently export sediment to the Bengal fan. Numerous slumps and slides observed in the canyon show small-scale acoustically transparent layers that indicate sediment liquefaction presumably initiated along the steep canyon margin. These mudflows move downslope and halt where the canyon gradient decreases. One widespread acoustically transparent layer with an age of approximately 140–160 years BP can be traced throughout much of the canyon and is probably the result of large-scale sediment remobilization triggered by a catastrophic event like an earthquake. This may represent decennial-to-centennial scale events that remove large quantities of sediment and prevent the canyon from rapid infilling.



Sediment transport in the shelf canyon "Swatch of No Ground" (Bay of Bengal) | Request PDF. Available from:

https://www.researchgate.net/publication/222673689_Sediment_transport_in_the_shelf_canyon_Swatch_of_No_Ground_Bay_of_Bengal [accessed Jan 03 2018].

4. Methodology

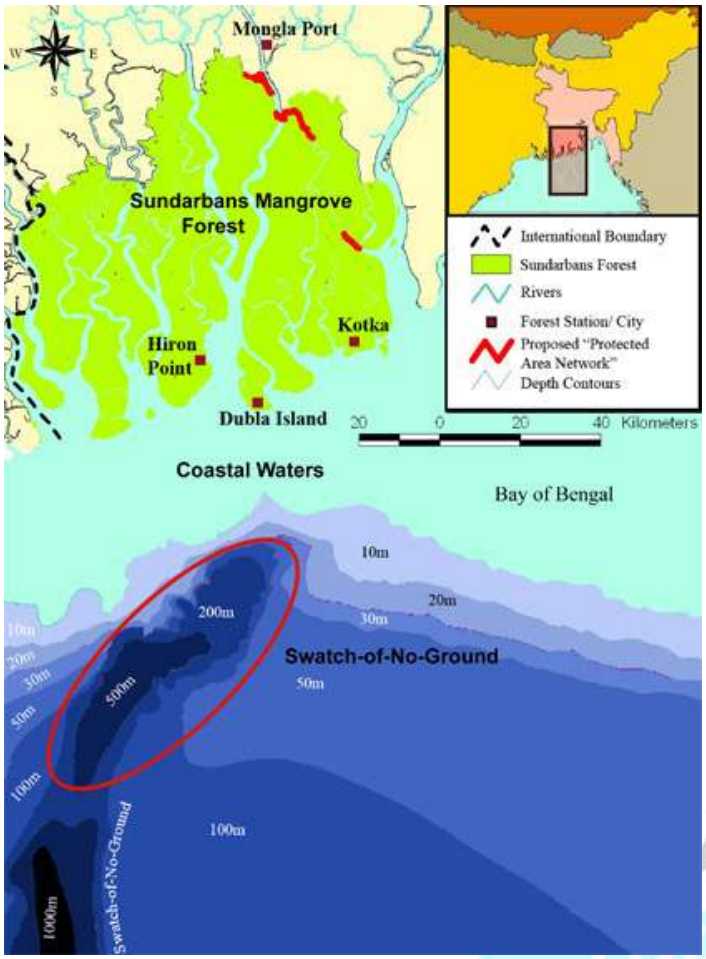
a. Desktop review and background document

Literature reviewed and the summary of those are:

Although the economic exploitation of marine resources dates back to prehistoric times, and historical documentation has existed since the third century B.C. with Aristotle's contributions in the Mediterranean Sea (e.g. [8]), the establishment of systematic collections of marine organisms began only during the seventeenth and eighteenth centuries. Global marine biodiversity investigations at these times depended not only on the availability of expertise, but also on foreign policies of the colonial powers of the time. For those reasons, the specimens collected from several regions (e.g., Caribbean, Japan, South America, Africa) were mostly brought to Europe, where they were described, deposited in museum collections, and used for the production of marine biological monographs. These early publications contained descriptions and checklists of many marine species, such as mollusks, crustaceans, fishes, turtles, birds, and mammals.

The history of research on marine biodiversity can generally be divided into three periods: early exploratory studies, local coastal “descriptive” studies, and large-scale multidisciplinary investigations and syntheses. These periods vary in timing by different seas and countries. The first exploratory studies in several regions (e.g., South America, Caribbean, South Africa, Pacific Ocean) took place from the mid-1700s until the late-1800s, in association with mainly European, North American, and Russian exploration expeditions, such as the Kamchatka Expedition in the 1740s, James Cook's voyages in the 1770s, the cruise of HMS Beagle in the 1830s, the voyage of HMS Challenger in the 1870s, and the first deep-sea investigations in the Mediterranean Sea. Pioneer investigations on deep-sea organisms were conducted in the Aegean Sea, where Forbes noticed that sediments became progressively more impoverished in terms of biodiversity with increasing sampling depth. The azoic hypothesis proposed by Forbes suggested that life would be extinguished beyond 500 m depth, although a work published 68 years earlier provided indisputable evidence of the presence of life in the Gulf of Genoa at depths down to 1,000 m.

Announced on October 27, 2014, the Swatch of No Ground (SoNG-MPA) is Bangladesh's first marine protected area. It is located in the Bay of Bengal at the head of a submarine canyon. It spans approximately 672 square miles (1,738 square kilometers) and is more than 900 kilometers in depth in some locations. The area is a key breeding and spawning ground for dolphins, whales, sharks and turtles. The marine protected area was established for the long-term protection of cetaceans that inhabit waters offshore of Bangladesh.



Source of image: http://whalesandmarinefauna.wordpress.com/2014/11/02/swatch-of-no-ground-declared-protected-zone-bangladesh/ (accessed November 9, 2014).

Note that the Swatch of No Ground only includes the area within the circle. This is an approximation of the location of the MPA.

Wildlife Circle, Bangladesh Forest Department, lists endangered dolphins, whales, porpoises and sharks found in the area.

They include Irrawaddy, pink river, bottlenose, spinner and spotted dolphins; finless porpoise; Bryde's, fin, humpback, sperm, dwarf sperm, killer or orca and false killer whales; and hammerhead, blue, whale, tiger and sawfish sharks.

WCS in its proposal document for establishing MPA reported that the SoNG, a 900+ m deep submarine canyon lying at the end of the geographic "cul-de-sac" of the Bay of Bengal, was formed about 125,000 years ago by erosive flows from the Ganges/Padma river system and underwater currents in the Bay of Bengal. The SoNG supports large numbers of Indo-Pacific bottlenose, pantropical spotted and spinner dolphins, and a likely resident population of Bryde's whales.

The canyon carries sediments that sustain the world's largest submarine fan and its cool, upwelled waters may serve as a refuge for cetaceans that cannot adapt to warming ocean temperatures or declines in productivity resulting from climate change. WCS also stated that sightings of Irrawaddy dolphins (114), finless porpoises (43), Indo-Pacific humpback dolphins (104), Indo-Pacific bottlenose dolphins (412), Bryde's whales (128), spinner dolphins (34) and pantropical spotted dolphins (29) were made during field studies conducted in winter seasons between 2004- 2012.

Spinner Dolphin

b. Team Building and mobilization

A 13 member team formed under "Quest for Sea & Life" by taking representation from the relevant discipline and research needs Prior to the expedition to SoNG a sensitization and orientation session was conducted at PMO where the rules, protocols and responsibilities of the RECO was discussed and framed. Maps and relevant literature and books were collected and bagged to use in the field. All logistics and equipment organized and packed ready to use manner.

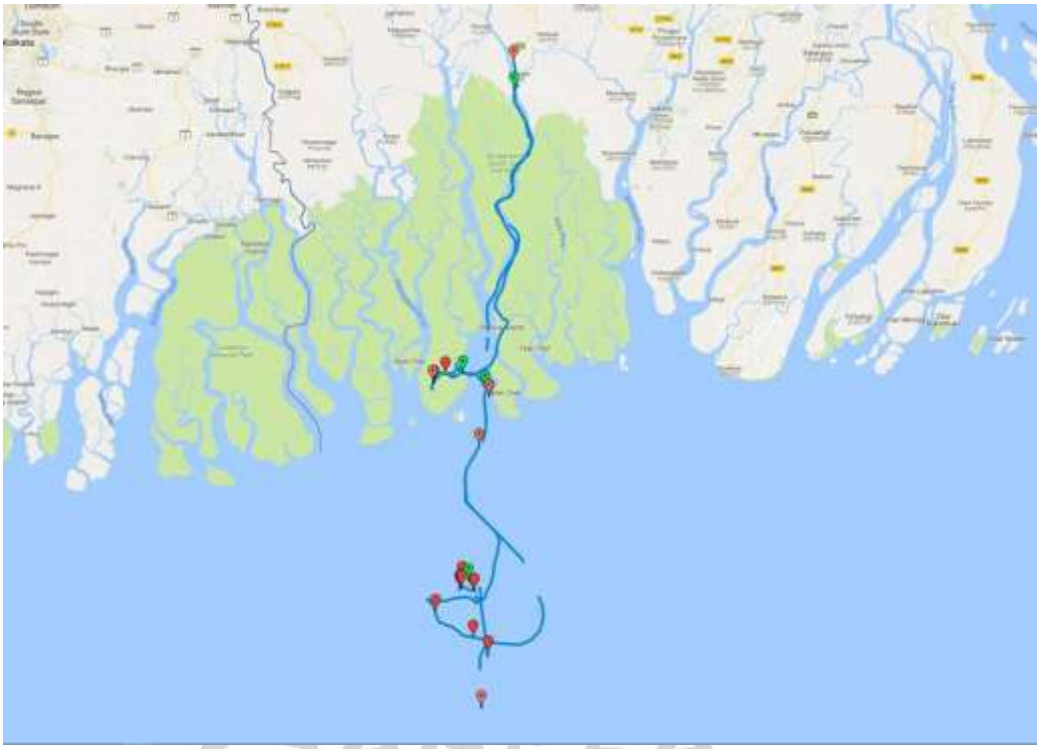
C. Logistic and equipment used

To conduct the study all relevant equipment and scuba diving gears were used. For documentation both still video photographs were taken. Three vessels were used to cruise the SoNG.

Isabela Team with Bangladesh Navy members on Board at Karotoa Ship

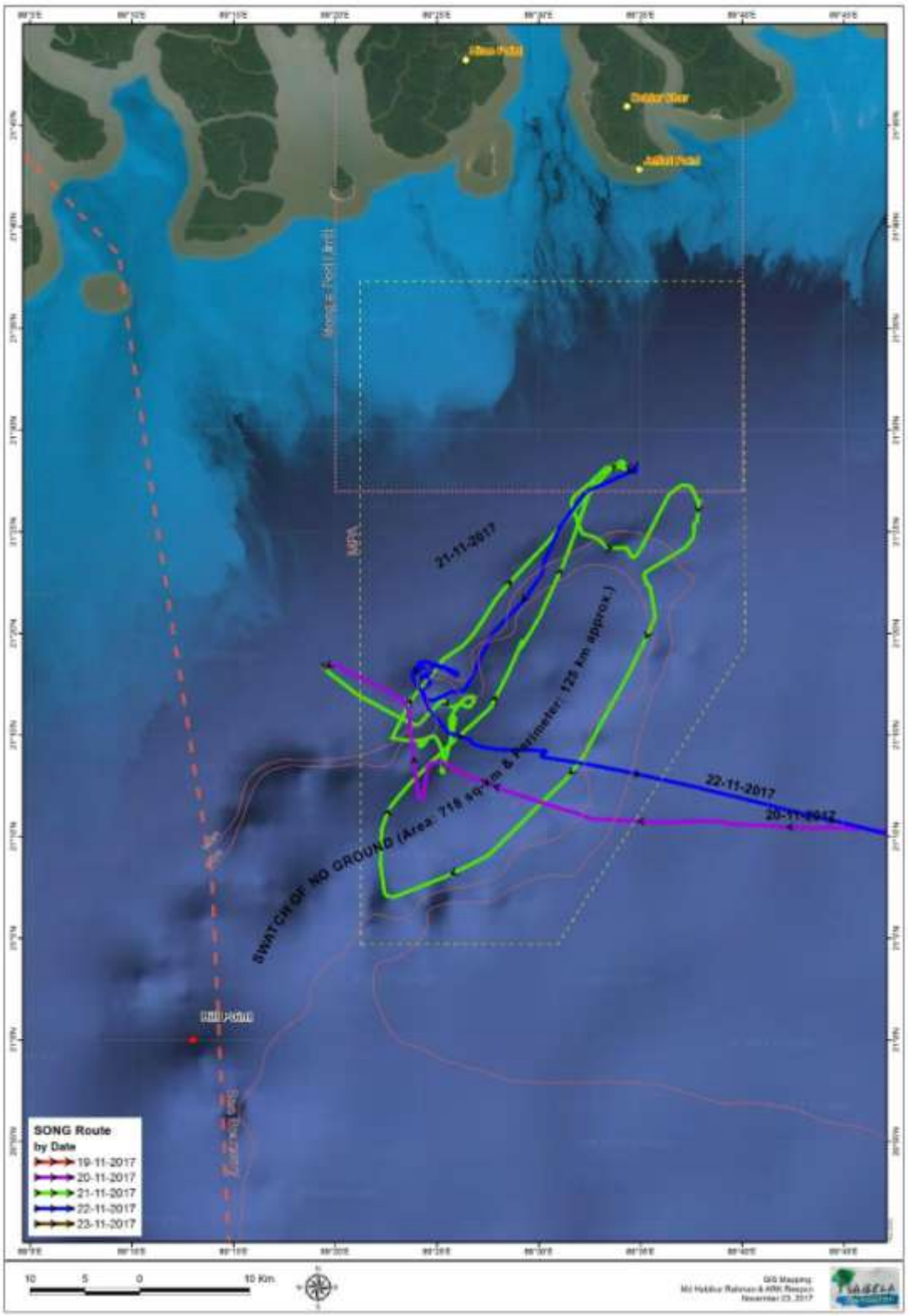
Isabela Underwater Research team with Bangladesh Navy divers

d. RECO routes map



e. Water vessels used in the Expeditions

Karota Ship of Bangladesh Navy


21-11-2017
22-11-2017
SWATCH OF NO GROUND (Area: 718 sq km & Perimeter: 125 km approx.)
SONG Route
by Date
19-11-2017
20-11-2017
21-11-2017
22-11-2017
23-11-2017
10 5 0 10 Km.

MV Torpedo

Floating Raft for facilitating move around @ SoNG

a. Standard methodology (FAO/IUCN-SSC-CSG,CI) are followed in observing the marinelife (invertebrates and vertebrates). Direct encounter, visual enumeration, spotting by bionics, recording images by still and movie camera are used to records the species sighted. The behavior of the wildlife was also noted by the enumerator of the team
b. The data on the bathymetry, water current, wave pattern, tidal pattern and visibility was jotted from the navigational charter of Bangladesh Navy.
c. Interviewed the KII fishers of the fishing vessels on spot.Checked the fish and marine invertebrates harvested by the fishing boats and photographed.

d. Results

4.1 Invertebrates

Group	Species	Comments
Crustaceans	11 species of Lobster, crabs other decapods	Individual of observed , photographed and identified
Mollusks	12 species Cockles' loligo, sepia, bivalves & others	DO
Coelenterates	3 species Jellyfish	DO
Echinoderms	4 species	DO
Others	Two unidentified coelenterates	

Decapods

Collection and preservation of specimen

Scorpion fish @ SoNG

Preserving specimen for future taxonomic study

5. Description of new species recorded for Bangladesh

Wikipedia based on compilation of secondary information stated that *Mirabilistrombus* listeri (Gray, 1852) a rare Conch found at swatch-of-no-ground during an expedition carried out by Isabela Foundation in collaboration with Bangladesh Navy and supported by PMO. The 13 membered Marine research team headed by Mr. Kabir Bin Anwar, Director General (Admn.) of Prime Minister's Office, conducted RBA (Rapid Biodiversity Assessment) at Bay of Bengal to learn about the marine research needs and identify the future course of actions. The team Isabela dived at bay and checked the specimen caught in the nets of deep sea fishing ship to record the marine flora and fauna . A pair of live conch univalve mollusk was found got entanlgled in the fishing net and collected for identification and for reference. Isabela taxonomic group studied the specimen and identified as Mirabilistrombus listeri.

As described by Encyclopedia Britannica, the group of conchs that are sometimes referred to as "true conchs" are marine gastropod molluscs in the family Strombidae, specifically in the genus Strombus and other closely related genera. The English word conch is attested in Middle English, coming from Latin concha (shellfish, mussel), which in turn comes from Greek konchē (same meaning) ultimately from PIE root *konkho-, cognate with Sanskrit śaṅkha

The meat of conchs is eaten raw in salads, or cooked, as in burgers, chowders, fritters, and gumbos. All parts of the conch meat are edible.

Conch shells can be used as wind instruments. They are prepared by cutting a hole in the spire of the shell near the apex, and then blowing into the shell as if it were a trumpet, as in blowing horn. Sometimes a mouthpiece is used, but some shell trumpets are blown without one.

Many different kinds of mollusks can produce pearls. Pearls from the queen conch, L. gigas, are rare and have been collectors' items since Victorian times. Conch pearls occur in a range of hues, including white, brown and orange, with many intermediate shades, but pink is the colour most associated with the conch pearl, such that these pearls are sometimes referred to simply as "pink pearls".

In Hinduism conch shell is used as a trumpet after Prayers and other rituals. It is also considered a sacred emblem of some Hindu Gods.

In the story of Dhruva, the divine conch plays a special part. The warriors of ancient India blew conch shells to announce battle, as is described in the beginning of the war of Kurukshetra, in the Mahabharata, the famous Hindu epic.

The god of preservation, Vishnu, is said to hold a special conch, Panchajanya, that represents life, as it has come out of life-giving waters.There is an interesting story behind the origin of a "the shankha" or conch shell.According to Hindu mythology, Devas (Gods) and Asuras (Demons) once decided to churn the ocean in order to get a special divine nectar. This divine nectar also known as "Amrit" was known to give immortality to whoever drank it. All the Gods were on one side of it and the Demons were on the other end. The Samudra Manthan produced a number of things from the Ocean. One of the first things to come out of it was lethal poison called

Halahala.Everyone was terrified as the poison was potent enough to destroy entire creation. So they went to Lord Shiva for protection and he consumed the poison to safeguard the universe. Lord Shiva took the poison in his mouth but did not swallow it. Later some additional objects came out of the ocean like Lakshmi (goddess of prosperity and beauty), Goddess of wine, Moon, divine Nymphs like Rambha- and Menakha, Uchhaishravas the divine seven headed White horse, Kaustubha a jewel, Parijata the celestial tree, Surabhi the cow of plenty, Airavata a white elephant, Dhanus a mighty bow and many more such things were produced. "Shankha" or conch shell also was one of divine objects that was obtained from Samudra manthan.

Buddhism has also incorporated the conch shell, Turbinella pyrum, as one of the Eight Auspicious Symbols.

Quetzalcoatl, the Mexican god of wind and learning, wears around his neck the "wind breastplate" ehecailacococozcatl, "the spirally voluted wind jewel" made of a conch shell.

Conch shells are sometimes used as decoration, as decorative planters, and in cameo making. In classic Maya art, conchs are shown being used in many ways, including as paint and ink holders for elite scribes, as bugles or trumpets, and as hand weapons (held by combatants by inserting their hands in the aperture). Conch shells have been used as shell money in several cultures.

Some American Aboriginals used cylindrical conch columella beads as part of breastplates and other personal adornment. In India, the Bengali bride-to-be is adorned with conch shell and coral bangles called "Shakha Paula. It is an important wedding ritual for every Bengali bride as it is an integral Bengali tradition.

Responding to a 2003 recommendation from CITES, some countries in the Caribbean have banned the export of queen conch shells. CITES has also asked all countries to ban import of these shells from countries that are not complying with CITES recommendations for managing the fishery. Queen conch fisheries have been closed in several countries. Conch shells or fragments taken home by tourists from noncomplying countries may be confiscated on return to the tourist's home country while clearing customs. In the UK, conch shells are the ninth most-seized import.

Mirabilistrombus listeri (Gray, 1852); Arafura Sea, between Aru and Australia; trawled by Indonesian fishermen at approx. 144 m; 2005; 116,8 mm; Ex-coll. Bunjamin Dharma; Coll. Kronenberg no. 6289

Conch Shell from Swatch- of- No- Ground, Photo by Kabir Bin Anwar, 24 march, 2017

Mirabilistrombus listeri (Gray, 1852)

Red Snapper, Tuna and Cat fishes found in the fishing vessel @ SoNG

6. ew record of Seabird for the First time In Bangladesh

Masked Booby a seabird sighted first time in Swatch-of-no-ground (SONG) at Bay of Bengal during an expedition carried out by Isabela Foundation on 23-24 March 2017. Under the leadership of Mr. Kabir Bin Anwar, Director General, Administration, Prime Minsters Office, a 13 membered research team of Isabela Foundation conducted a reconnaissance survey to understand the marine biological diversity of the SONG Marine Protected Area (MPA). The team Isabela first spotted and photographed the bird flying on the sky at the Swatch-of –no-ground (21° 17'17.05" N 089° 29'23.59" E) on 24th of March 2017. Mr. Rashedul Kabir Bhyuian , Wildlife Officer of Bangladesh Forest Department along with Team Isabela identified the species together with concurrence from Dr. Anisuzzaman Khan, Wildlife Scientist and Chief Advisor, Isabela Foundation .

Isabela team Reviewed and researched the Taxonomic keys and source of Birdlife International, IUCN RDB and that of del Hoyo, J., Collar, N.J., Christie, D.A., Elliott, A. and Fishpool, L.D.C. 2014. HBW and Illustrated Checklist of the Birds of the World for identification of the species and confirmed the species as Masked Booby.

The **masked booby** (*Sula dactylatra*) is a large seabird of the booby family, Sulidae. This species breeds on islands in tropical oceans, except in the eastern Atlantic; in the eastern Pacific it is replaced by the Nazca booby, *Sula granti*, which was formerly regarded as a subspecies of masked booby. It is also called the **masked gannet** or the **blue-faced booby**.

This is the largest booby, at 74–91 cm (29–36 in) long, with a 137–165 cm (54–65 in) wingspan and 1.2–2.35 kg (2.6–5.2 lb) weight. Adults are white with pointed black wings, a pointed black tail, and a dark grey facemask. The sexes are similar, but the male has a yellow bill, and the female's is greenish yellow; during the breeding season they have a patch of bare, bluish skin at the base of the bill. Juveniles are brownish on the head and upperparts, with a whitish rump and neck collar. The underparts are white. The masked booby is silent at sea, but has a reedy whistling greeting call at the nesting colonies. While on the breeding grounds, these birds display a wide range of hissing and quacking notes.Masked boobies are spectacular divers, plunging diagonally into the ocean at high speed. They mainly eat small fish, including flying fish.

Masked Booby, Courtesy © Rafael Sanchez, Aruba, December 2011

The Masked Booby *(Sula dactylatra)* has an extensive distribution in tropical and subtropical parts of the Indian, Pacific and Atlantic Oceans, breeding on oceanic islands between ~30"S and ~30°N (Marchant and Higgins 1990; Pitman and Jehl 1998).

The global population size has not been formerly assessed, although Pitman et al (Pitman RL et. al. 2005) . Speculate that it is probably upward of 225,000 breeding pairs. Masked boobies are believed to be decreasing globally but the rate of decline does not meet thresholds for Vulnerable under the IUCN Red List classification scheme (Birdlife International 2017)

7. Vertebrates

Group	Species	Comments
Pisces	35 species grouper, sardine, perch, knife, eel, catfish, Shark, Pomfret, flat fish	Specimen seen, photographs, measured and identified
Turtles	2 species Hawksbill, Green turtle	DO
Snakes	5 Species	DO
Birds	18 species Gulls, terns, booby, noody, waders, tropic birds	Tropic bird, Masked Booby, Albatross are new record for Bangladesh's avifaunal list
Mammals	7 species of Cetacea: whales, dolphins and porpoises	DO

8. **Flora**

During the study two species of sea grass and 4 species of marine algae were found and documented

Seagrasses, marine flowering plants, have a long evolutionary history but are now challenged with rapid environmental changes as a result of coastal human population pressures. Seagrasses provide key ecological services, including organic carbon production and export, nutrient cycling, sediment stabilization, enhanced biodiversity, and trophic transfers to adjacent habitats in tropical and temperate regions. They also serve as "coastal canaries," global biological sentinels of increasing anthropogenic influences in coastal ecosystems, with large-scale losses reported worldwide. Multiple stressors, including sediment and nutrient runoff, physical disturbance, invasive species, disease, commercial fishing practices, aquaculture, overgrazing, algal blooms, and global warming, cause seagrass declines at scales of square meters to hundreds of square kilometers. Reported seagrass losses have led to increased awareness of the need for seagrass protection, monitoring, management, and restoration. However, seagrass science, which has rapidly grown, is disconnected from public awareness of seagrasses, which has lagged behind awareness of other coastal ecosystems. There is a critical need for a targeted global conservation effort that includes a reduction of watershed nutrient and sediment inputs to seagrass habitats and a targeted educational program informing regulators and the public of the value of seagrass meadows.

9. Discussion

Subrahmanyam, V. ; Krishna, K.S.; Ramana, M.V.; Murthy, K.S.R. 2008 described that multibeam swath bathymetry, gravity and magnetic investigations were conducted across the major deltafront canyon known as Swatch-of-No-Ground in the northern Bay of Bengal. The study reveals that the canyon is a 300 m deep and 18 km wide depression with step-like micro-terraces running in NNE-SSW direction. The depth to the seafloor topography varies from 900 to 1459 m with 100-150 m thick levee sediments deposited on both the edges of the canyon as seafloor swells spreading over a distance of 10-20 km. In the area north of the 20°07'N lat., the canyon is characterized by a gentle step-like slope towards the western flank and a steep slope towards the eastern flank, while in the area south of the 20°07'N lat., the morphology of the canyon is vice versa. The anatomy of the canyon suggests that the turbidity sediments flow in a semi-circular manner within it. When the muddy sediments strike the flank within the canyon, a part gets bounced-off in an orthogonal direction to the semicircular turbidity flow leading to the formation of steplike small terraces on the other flank of the canyon. The canyon is associated with a low gravity field of about 15 mGal and weak magnetic field of the order of 30-40 nT. The model study revealed that the submarine canyon is not associated with any structural discontinuities such as faults and folds. Hence, it is surmised that the submarine

canyon is a morphological feature formed by major river flow and underwater currents in the northern Bay of Bengal.

Spanning some 672 square miles (1,738 square kilometres) in size with a depth of 900+ meters, the Swatch of No Ground Marine Protected Area includes deep waters at the head of the submarine canyon from which it gets its name as well as coastal waters offshore the world's largest mangrove forest in the Sundarbans.

The Bangladesh Cetacean Diversity Project implemented by WCS worked along with the Government of Bangladesh since 2004 to ensure the long-term protection of the cetaceans in waters of Bangladesh through collaborative efforts with local communities.

"The SOS funded project saving threatened coastal cetaceans in collaboration with gillnet fishermen in coastal waters of Bangladesh also played a major role in contributing information to plans for the MPA" explained Brian Smith, Director, Asian Freshwater and Coastal Cetacean Program, Wildlife Conservation Society and Asia Coordinator, IUCN SSC Cetacean Specialist Group.

WCS reported that Irrawaddy dolphins range in near- and inshore waters of the western Pacific and eastern Indian Ocean in habitat generally associated with river mouths. They also occur far upstream in three large rivers including the Ayeyarwady in Myanmar, Mekong in Cambodia and Laos, and Mahakam in Indonesia. Five Critically Endangered populations occur in the three large rivers mentioned above and in Chilikha Lagoon, India, and Malampaya Sound, Philippines. Popultions generally number in the 10s to low 100s with the single exception of Bangladesh which supports approximately 5,800 dolphins. About 400 of these dolphins occur in waterways of the Sundarbans and 5,400 in the coastal waters offshore of the mangrove forest.

Khan, A.Z pers.com (2010) described that the numbers of Irrawaddy dolphin is widely distributed in the marine water of Bangladesh andalso found entering into coastal zone, inshore and estuary of Naaf River, Moheshkhali- Sonadia-Kutubdia channel, Swandweep- Hatiya Monpura Channel and Kuakata-Sundarban's coast. Highest density recorded from the East Coast along the shallower water zone of Saint Martin's gulf.

Sea birds recorded in the SoNG Greater crested tern (Sterna bergii) Lesser crested tern (Sterna bengalensis) Brown headed gull (Larus brunnicephalus) Black headed gull (Larus ridibundus) Common tern (Sterna hirundo) Whiskered tern (Chilidonius hybridus)

Marine scientists have discovered that two species of dolphin in the waters off Bangladesh are genetically distinct from those in other regions of the Indian and western Pacific Oceans, a finding that supports a growing body of evidence that the Bay of Bengal harbors conditions that drive the evolution of new life forms, according to a new study by the American Museum of Natural History(AMNH), WCS (Wildlife Conservation Society), and the cE3c - Centre for Ecology, Evolution and Environmental Changes (Universidade de Lisboa).

In the comparative study using DNA collected from both Indo-Pacific humpback dolphins (*Sousa chinensis*) and Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) and data from previous genetic studies, the authors of a newly published paper in *Conservation Genetics* have found that both populations of both species are distinct from populations in other parts of the Indian Ocean and western Pacific. This discovery follows the recent description of a possible new species of "river shark" in the same waters.

The authors of the study titled "Oceanic drivers of population differentiation in Indo-Pacific bottlenose (Tursiops aduncus) and humpback (Sousa spp.) dolphins of the northern Bay of Bengal" are: Dr. Ana R. Amaral of cE3c, Universidade de Lisboa, Portugal and AMNH's Sackler Institute of Comparative Genomics; Brian D. Smith and Rubaiyat M. Mansur of WCS; and Dr. Howard C. Rosenbaum of WCS and affiliated with AMNH.Marine waters of Bangladesh are also having 442 species of fish36 species of marine shrimps. About 336 species ofmollusks, covering 151 genera have been identified. Inaddition, 3 lobsters and 7 species of turtles and tortoises, 168species of seaweeds, 3 sponges, 16 crabs, 3 lobsters,

However, there is no consolidated report on how many snail species are there in Bangladesh. Ahmed (1990) and Jahan et al. (1990, 1993) reported 212 species of marine snails from the coastal waters of Bangladesh under 80 genera, 40 families and 5 orders.

10. Research Needs

Limnology

In parallel with oceanography, limnology examines physical, hydrological, chemical and biological processes and their interactions in inland waters and their watersheds. A major focus of these studies is on interdisciplinary research aimed at measuring the sources, fluxes and fates of land-derived materials in streams, and their ecological effects on freshwater, estuarine and coastal marine habitats.

Research Centers

The Marine Science Institute should provide administrative support to a number of centers for innovative and collaborative marine science research, connecting research to policy, and fostering training and outreach.

Climate Change Science

Over the coming decades, global climate change will have profound impacts on marine and freshwater ecosystems worldwide. Changing climate patterns are likely to affect ocean temperature, chemistry, currents and waves, and lead to large changes in the abundance and distribution of individual species and the functions of entire ecosystems. Similarly, changing snow/rainfall and melt patterns affecting flow timing and variability are expected to have disruptive ecological consequences for freshwater systems. Research in climate change science

require to examines how climate change has affected ocean and freshwater conditions in the past as well as how it is likely to affect them in the future.

Marine Conservation, Policy and Education

Marine and coastal policy issues are becoming increasingly important throughout the world. Studying the sustainability of marine resources and applying their knowledge to inform stakeholders and policy makers on best practices for science-based management. Active areas of research include fisheries management, marine spatial planning, restoration, and methods for increasing science literacy with a goal towards promoting conservation and stewardship of our natural heritage for future generations.

Natural Marine Resources

The marine resources play a vital role in sustaining the needs of society. A diverse array of marine organisms are used for food, medicine, cosmetics, and a wealth of industrial applications, while the world's demands for energy, minerals and water have become increasingly dependent on non-living marine resources. Research required to monitor and assess the condition of the Sea's resources and to determine the impacts that humans have on them through fishing, offshore oil and gas operations, coastal development and municipal and industrial discharges. The focus is on gaining a comprehensive understanding of coastal and island ecosystems, which is necessary for sound resource management.

Ecology, Evolution and Genetics

Solutions to many of the world's most pressing environmental issues require a basic understanding of nature at the organismal, population and ecosystems level. Research on genetics and evolution provides critical insight into how environmental factors influence an organism's physiology and behavior, and ultimately the ecological functions of ecosystems and the services that they provide. Researchers should strive to develop the scientific understanding of ecology, evolution and genetics needed to address environmental issues ranging from changes in biodiversity and ecosystem function, to the spread of invasive species, parasites and disease.

Marine Geology and Geophysics

Management and stewardship of the world's oceans demands an understanding of environmental change on processes and resources occurring below the ocean as well as within it. Scientists working in Marine Geology and Geophysics , conduct research on the geology and geophysics of ocean basins, ridges, and continental margins to provide a broad, inter-disciplinary understanding of processes acting on the Earth's crust and mantle beneath the oceans. Active areas of research include: tectonic evolution and volcanic activity of ocean basins, continental margins, mid-ocean ridges, and island arc systems; processes controlling the deposition, erosion and transport of marine sediments; hydrocarbon cycling and the

interactions between microbes and the Earth system; and active submarine faulting and seafloor deformation.

Biotechnology and Engineering

This exciting field uses the latest breakthroughs in modern molecular biology, engineering and chemistry to solve basic problems in marine biology; to improve the production of medical, chemical, food, and energy resources from the ocean; and to develop new products and industries based on more efficient use of the ocean's resources. Research and training in Marine Biotechnology need to focus in three inter-related areas: the development of new methods and approaches from molecular and cellular biology to investigate the basic mechanisms controlling life in the oceans and its responses to environmental change; (2) the development of new industries, resources and products from the oceans; and (3) the use of marine organisms as models for biomedical research.

11. Conclusion and Recommendations

Biodiversity is the variety of living organisms and their habitats: the structure,composition, dynamics, and function of living systems acquired over millions of years of evolution. Marine biodiversity is extremely rich but is poorly understood and has only recently become the subject of conservation concerns (Norse, 1993). Biodiversity refersto the spatial organization of plants and animals in a hierarch at the genetic, organism, population, species, community, ecosystem, and seascape levels (Hughes and Noss, 1992; Norse, 1993). Major threats to biodiversity are habitat destruction, environmental changes, and overfishing (Upton, 1992). Losses of biodiversity at the genetic and species levels are of special concern because they are permanent.

At a time when diversity of oceanic fishes is threatened, fishery management can no longer strive simply to maximize yield while ignoring biological interactions, the physical and biological environments, and impacts of fishing gears and catches on habitat and biodiversity. There is a clear need to improve monitoring methods and change from single species management to ecosystem management to protect marine biodiversity and promote sustainable use. Research and education are essential to increase public appreciation of biodiversity and the impacts of human activities. Both resource managers and users need to develop realistic expectations and a risk-averse philosophy toward resource exploitation and management effectiveness. The urgent need to lear, establish knowledge base and ensure sustainable use of marine resources the following actions are of utmost important

- Marine Biodiversity Inventory is required
- Identification Key Biodiversity Areas and Protection of the same as Marine Protected Areas
- Marine Biodiversity Organization

- Marine Research Lab, Ship, Diving, Patrolling and other necessary modern logistics
- Control over the deep sea fishing
- Compliance with Basel, Rotterdam, MARPOL, Stockholm , CBD, Ramsar, and Bonn Convention
- Marine Pollution Control

To meet the future needs and challenges in studying marine biodiversity, we recommend improved coordination between institutions, including museums, fisheries institutes, government and intergovernmental agencies, and universities at the international, national, and regional levels to (1) formally agree on key gaps in knowledge, (2) appoint staff to fill gaps strategically as positions become available, (3) facilitate staff exchange to fill gaps and train staff in other countries, (4) facilitate graduate training to address gaps, and specifically to cope with the progressive loss of taxonomic expertise, (5) host workshops (including field studies) and symposia to generate team-building and a sense of urgency and momentum amongst participants to address gaps, (6) support low-cost, open-access publication of knowledge through e-journals and authoritative online species information systems (including digital species identification guides), (7) develop new technologies for ocean exploration, knowledge discovery, data management and dissemination of results, and (8) encourage international collaboration between countries to facilitate field work, strategically build specimen collections, and publish data and knowledge online. Leadership for such coordination will need to come from champions in the scientific community, key institutions (e.g., those that host databases and publications), and countries that fund the institutions and scientists. This study comes at the end of a decade of the Census of Marine Life. We show that there remain major gaps in basic knowledge of marine biodiversity, taxonomically and geographically. Science and society would thus benefit from another decade of discovery that strategically builds on our findings.

Way forward

Bay of Bengal is an attention-grabbing marine biome as far as its biological diversity is concern. Most of the information pertaining to marine resources of Bay of Bengal in Bangladesh's jurisdiction available at present is particularly on its Icthyofuana. A few sporadic survey is carried out on the coastal aquatic biological resources which again mainly focused on fish and avifauna. Be that may be whether Blue Economy or management of marine resources of Bangladesh, there is a dire need to have an inventory of marine resources, comprehensive enough for long term strategic planning to attend the UN-SDG 14 at national level.

We all are aware about the importance of biological diversity, its goods and services for mankind. We also aware about the threats and continuous erosion of our precious genetic resources at marine biome. But we still are not fully aware about the state of gene bank of marine species of flora and fauna compare to that of terrestrial one. Hence this initiative "Quest for Sea and Life" of Isabela Foundation is to learn about non-fish renewable and no-renewable natural resources of marine biome of Bangladesh. Very recently Isabela foundation organized an exploration at Swatch-of-No- Ground (SoNG) in collaboration with Bangladesh Navy and identified the priority needs in marine research (annex-I). Those findings of SoNG exploration had shared with Ministry of Fisheries and Livestock's and Department of Environment at Bangladesh Secretariat. The recommendations made by Isabela foundation was appreciated by the Ministry and asked the foundation to submit a proposal for future course of action. It was also decided that this initiative required to be merged with the ongoing programme of the Ministry to add value in collecting information on non-fish biodiversity and marine ecology. It is an opportunity to have national capacity building program through Public-Private Partnership in marine research and oceanographic studies, skill building through on-job training of young scientist on board of Meen Sandhani ,modern research vessel of Department of Fisheries .

The countries in the Bay of Bengal Region have their own National Marine Biodiversity Conservation Prorgramme as an integral part of NBASP/NEMAP/Agenda-21. However, implementations of such strategies are mostly restricted to marine resources harvest and protection of some mega fauna only. As far as greater seascape ecosystem is concern, we are lagging behind. Hence appropriate marine biodiversity conservation is dependent upon a clear scientific rationale for practical interventions. The main focus is on benthic species living on or in the seabed and immediately above, rather than on commercial fisheries or highly mobile vertebrates. Such species, including algae and invertebrates, are fundamental to a stable and sustainable marine ecosystem. There is a practical need to guide in ecosystem based-approach with a clear exposition of the principles of marine ecology and species biology to demonstrate how marine conservation issues and mechanisms have been tackled worldwide and especially the criteria, structures and decision trees that practitioners and managers will find useful.

Hence this "Quest for Sea and Life" (QfSL) is a timely an initiative which in collaboration with MOFL and Bangladesh Navy would learn about marine research technologies and generate primary data for making science-based far reaching marine resources management planning by the government.

12. References

Proposal to establish a marine protected area in the Swatch-of-No-Ground submarine canyon and surrounding coastal waters in the Bay of Bengal Prepared by the Wildlife Conservation Society's Bangladesh Cetacean Diversity Project (e-mail: cetacean.bangladesh@gmail.com; bsmith@wcs.org)

Mansur, R.M., Strindberg, S. and Smith, B. 2012. Mark-resight abundance and survival estimation of Indo-Pacific bottlenose dolphins, Tursiops aduncus, in the Swatch-of-No-Ground, Bangladesh. Marine Mammal Science.

Smith, B.D., Braulik, G., Strindberg, S., et al. 2006.Abundance of Irrawaddy dolphins (Orcaella brevirostris) and Ganges river dolphins (Platanista gangeticagangetica) estimated using concurrent counts from independent teams in waterways of the Sundarbans mangrove forest in Bangladesh. Marine Mammal Science. 22(3): 527-547.

Smith, B. D., Ahmed, B., Mansur, R., et al. 2008. Species occurrence and distributional ecology of nearshore cetaceans in the Bay of Bengal, Bangladesh, with abundance estimates for Irrawaddy dolphins Orcaella brevirostris and finless porpoises Neophocaena phocaenoides.Journal of Cetacean Research and Management.10(1):45–58.

Smith, B.D., Strindberg, S., Aguilar, A., and Mansur, R.M. 2008. Swimming against the rising tide: The use of cetaceans for evaluating the ecological impacts of declining freshwater supplies and global climate change in Bangladesh.International Whaling Commission, Scientific Committee Document SC/60/E12

In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. Bearzi, G., Bjørge, A., Forney, K.A., Hammond, P.S., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. 2012. Stenella longirostris. Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. 2012. Tursiops aduncus. Hammond, P.S., Bearzi, G., Bjørge, A., Forney, K.A., Karkzmarski, L., Kasuya, T., Perrin, W.F., Scott, M.D., Wang, J.Y., Wells, R.S. & Wilson, B. 2012. Stenella attenuata. Reeves, R.R., Dalebout, M.L., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y. & Zhou, K. 2008. Sousa chinensis. Reeves, R.R., Jefferson, T.A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E.R., Slooten, E., Smith, B.D., Wang, J.Y. & Zhou, K. 2008. Orcaella brevirostris. Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. Balaenopteraedeni. Wang, J.Y. & Reeves, R. 2012. Neophocaena asiaeorientalis. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. Other

ATA Ahmed, Studies on the identity and abundance of molluscan fauna of the Bay of Bengal. Bangladesh Agriculture Research Council, Contract Research Project Report, 1990;

MS Jahan, MA Mannan, and MN Mandal, Intertidal Molluscs of the Sundarbans, Bangladesh. Environment and Ecology 8(2): 603-607, 1990; MS Jahan, Some terrestrial and freshwater gastropods of Bangladesh with their ecological notes. Univ. J. Zool. Rajshahi Univ. 12: 65-71, 1993.

Bouchet P Duarte CM, editor. (2006) The magnitude of marine biodiversity. The exploration of marine biodiversity: Scientific and technological challenges 33–64: P. Bouchet2006The magnitude of marine biodiversity.CM DuarteThe exploration of marine biodiversity: Scientific and technological challenges33–64Fundación BBVA, Madrid. Fundación BBVA, Madrid.

Eschemeyer WN, Fricke R, Fong JD, Polack D (2010) Marine fish biodiversity: A history of knowledge and discovery (Pisces). Zootaxa 2525: 19–50.WN EschemeyerR. FrickeJD FongD. Polack2010Marine fish biodiversity: A history of knowledge and discovery (Pisces).Zootaxa25251950

Costello MJ, Emblow CS, Bouchet P, Legakis A (2006) European marine biodiversity inventory and taxonomic resources: State of the art and gaps in knowledge. Marine Ecology Progress Series 316: 257–268.MJ

Liu JY, editor. (2008) Checklist of the marine biota of China seas. Beijing: Science Press, Academia Sinica. JY Liu2008Checklist of the marine biota of China seas.BeijingScience Press, Academia Sinica

Wafar M, Venkataraman K, Ingole B, Khan A, Lokabharathi PA (2010) State of knowledge of coastal and marine biodiversity of Indian Ocean countries. Personal communication. M. WafarK. VenkataramanB. IngoleA. KhanPA Lokabharathi2010State of knowledge of coastal and marine biodiversity of Indian Ocean countries.

Ekman S (1953) Zoogeography of the sea. Sidgwick and Jackson 417: London.S. Ekman1953Zoogeography of the sea.Sidgwick and Jackson417London

Costello MJ, Vanden Berghe E (2006) “Ocean Biodiversity Informatics” enabling a new era in marine biology research and management. Marine Ecology Progress Series 316: 203–214.MJ CostelloE. Vanden Berghe2006“Ocean Biodiversity Informatics” enabling a new era in marine biology research and management.Marine Ecology Progress Series316203214

Subrahmanyam, V. ; Krishna, K.S.; Ramana, M.V.; Murthy, K.S.R.Marine geophysical investigations across the submarine canyon (Swatch-of-No-Ground), northern Bay of Bengal Curr. Sci.: 94(4); 2008; 507-513.

Shanmugam, G. (2016). "Submarine fans: A critical retrospective (1950–2015)". Journal of Palaeogeography. 5 (2): 110-184. doi:10.1016/j.jop.2015.08.011.

Jump up ^ Curray, Joseph R.; Frans J. Emmel; David G. Moore (December 2002). "The Bengal Fan: morphology, geometry, stratigraphy, history and processes". Marine and Petroleum Geology. Elsevier Science Ltd. 19 (10): 1191–1223. doi:10.1016/S0264-8172(03)00035-7.

Jump up ^ Cochran, J.R.; Stow, D.A.V.; et al. (1989). "116 Initial Reports Table of Contents". Proc. ODP, Init. Repts. Ocean Drilling Program College Station, TX. 116. doi:10.2973/odp.proc.ir.116.1989.

Jump up ^ France-Lanord, Christian; Derry L.; Michard A. (1993). "Evolution of the Himalaya since Miocene time: isotopic and sedimentological evidence from the Bengal Fan". Geological Society Special Publication. 74: 603–621. doi:10.1144/GSL.SP.1993.074.01.40.

^ Jump up to: a b Tilmann Schwenk; Volkhard Spiess (2009). "ARCHITECTURE AND STRATIGRAPHY OF THE BENGAL FAN AS RESPONSE TO TECTONIC AND CLIMATE REVEALED FROM HIGH-RESOLUTION SEISMIC DATA". SEPM Special Publication, No. 92. External Controls on Deep-Water Depositional Systems. SEPM (Society for Sedimentary Geology). pp. 107–131. ISBN 978-1-56576-136-0.

^ Jump up to: a b c France-Lanord, Christian; Volkhard Spiess; Peter Molnar; Joseph R. Curray (March 2000). "Summary on the Bengal Fan: An introduction to a drilling proposal" (PDF). Woods Hole Oceanographic Institution.

Jump up ^ Curray, Joseph R.; David G. Moore (March 1971). "Growth of the Bengal Deep-Sea Fan and Denudation in the Himalayas". Geological Society of America Bulletin. 82 (3): 563–572. doi:10.1130/0016-7606(1971)82[563:GOTBDF]2.0.CO;2

Books and Reports

Jefferson, T.A., Webber, M.A. and Pitman, R.L. 2008. Marine Mammals of the World. A Comprehensive Guide to their Identification.

Elsevier, Amsterdam. Minton, G. and Smith, B. (eds) 2011. Final Report Determining and Quantifying Threats to Coastal Cetaceans: A Regional Collaborative Workshop

Kuching, Sarawak, Malaysia. Perrin, W.F., Würsig, B., Thewissen, J.G.M. (eds.) 2009. Marine Mammals of the World (2nd edition). Academic Press, San Diego.

Hoyt, E. 2011.Marine Protected Areas for Whales, Dolphins and Porpoises.

A Handbook for Cetacean Habitat Conservation and Planning. Earthscan, London and New York.

Proc. of International Conference on Environmental Aspects of Bangladesh (ICEAB10), Japan, Sept. 2010 - 83 - FB08 Coastal and marine biodiversity of Bangladesh (Bay of Bengal)

O. Quader Space Research and Remote Sensing Organization (SPARRSO), Dhaka-1207, Bangladesh

Sediment transport in the shelf canyon "Swatch of No Ground" (Bay of Bengal) | Request PDF. Available from:

https://www.researchgate.net/publication/222673689_Sediment_transport_in_the_shelf_canyon_Swatch_of_No_Ground_Bay_of_Bengal [accessed Jan 03 2018].