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Herpetofaunal species richness in the tropical forests of Bangladesh

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ABSTRACT

Species richness is one of the most commonly used biodiversity metrics in ecology and conservation planning, and an important indicator for monitoring biodiversity. Between 2006 and 2009, we recorded 938 individual amphibians and reptiles representing 100 species (27 amphibians and 73 reptiles) from Bangladesh. We used EstimateS to calculate herpetofaunal species richness at each of our eight study sites, representing all major habitat types in Bangladesh. Species richness ranged from 23 -71 species and varied significantly among sites. The highest herpetofaunal species richness was found in Kaptai National Park whereas the lowest was from Comilla Tipperah Hills. Chao-Jaccard Similarity Indices ranged from 0.41 (Comilla Tipperah Hills and Sundarbans Reserve Forest) to 0.78 (Kaptai National Park and Lawachara National Park), indicating that species compositions were not generally similar among sites. Three sites (Kaptai National Park, Lawachara National Park, and Bandarban Hill District) stand out as having especially high diversity of both amphibians and reptiles, whereas Madhupur National Park supports some unique amphibians. These four sites act as major refuges for amphibian and reptile species in Bangladesh and should be given highest priority for herpetofaunal conservation efforts.

Key words: amphibian; Bangladesh; herpetofuana; reptile; species richness; and tropical forest.

INTRODUCTION

The selection and management of conservation areas in biodiversity-rich tropical regions poses many challenges (Pawar *et al.,* 2007). On the one hand, tropical countries have some of the fastest rates of degradation of natural land cover, while on the other, they are generally data-poor and cash-strapped (Myers *et al.,* 2000; Mittermeier *et al.,* 2004). Both factors are of concern for successful conservation of the amphibian and reptile fauna of Bangladesh (IUCN Bangladesh 2000; Kabir *et al.,* 2009). Very little new information on the herpetofauna of the country has been added since the end of the British colonial period about 75 years ago. Population pressure in Bangladesh is intense, poverty levels are high, and maintaining biodiversity is an especially large challenge. Bangladesh is losing its forest cover at an alarming rate and on rise in the recent decades. The forests in Bangladesh cover less than 6% of the total area (in early 2000s), compared to at least 17% in 1971 (Gain, 2002). The annual loss of natural forest averaged 2.1% over the 20-year period ending in the early 1980s and 2.7% in the period between 1984 and 1990 (FMP, 1992). Between 1990 and 2005, Bangladesh lost more than 11,000 hectares of its remaining forest cover (IUCN Bangladesh, 2000). Protected areas account for only 2% of the total area of Bangladesh (FD, 2011) and harbor most of the amphibian and reptile species diversity in Bangladesh (Reza, 2010).

Bangladesh is currently experiencing an 'age of herpetofaunal discovery'. Of the 51 species of amphibians (Reza, 2014) and 136 species of reptiles (Kabir *et al*., 2009) currently known, at least 29 amphibians and 27 reptiles have been reported from Bangladesh for the first time in the past decade (IUCN Bangladesh, 2000). Yet this number is surely an underestimate. Generally, forests challenge investigators wishing to sample herpetofauna because of the dense under- and over-story, low light conditions, extreme rainfall, and high humidity (Inger 1980; Scott 1994; Pearman *et al*., 1995). Some standard sampling methods are difficult to implement or are completely inappropriate for tropical forest surveying. For example, because of the lack of roads in many tropical forests, night driving may be impossible. Doan (2003) provided quantitative data on the efficacy of herpetofaunal survey methods and concluded that the Visual Encounter Survey (VES) is the technique most suitable for sampling tropical forest herpetofauna. However, because of unequal detection probabilities as well as sampling inadequacy, the number of species observed during sampling period is inevitably an underestimate of the true species richness (Colwell and Coddington, 1994; Chao *et al.,* 2000; Cam *et al.,* 2002; Brose *et al.,* 2003).

Species richness, defined by the number of species present in a specified time and space, is one of the most commonly used metrics in ecology and biodiversity management planning (Margules and Pressey,

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2000; Lamoreux *et al.,* 2006). Species richness is important for comparing animal communities, for assessing the effects of human disturbance on biological diversity, and for making environmental policy decisions. Accurately estimating species richness is therefore a crucial concern (Boulinier *et al.,* 1998). Although simple in theory (Gaston, 1996), the measurement of true species richness is confounded by heterogeneous detection probabilities among species, as well as by biases of the survey method/s used. Detection probability varies between individuals, species, habitats, seasons and sampling methods (Burnham and Overton,1978; Colwell and Coddington, 1994; Boulinier *et al.,* 1998). New species richness estimators have recently been developed in an attempt to overcome the limitations of estimating true species richness (Colwell, 2009), and non-parametric richness estimators have in recent reviews been shown to be the best-performing type of estimator (Walther and Moore, 2005). Given these new tools, the current study was designed with two major objectives: i) to measure species richness in the selected eight sites in Bangladesh while assessing the performances of popular species richness estimators; and ii) to rank the study sites for immediate conservation management based on species richness and species similarity index criteria.

METHODS

Study area and species

Between 2006 and 2009 we sampled representatives of all major habitat types in Bangladesh. In its 147,570 km^2 total area, the country supports mixed evergreen forest, semi-evergreen forest, mangrove forest, deciduous forest, and swamp forest. The majority of the low-land areas have been converted to agricultural lands or urbanized. Keeping the habitat diversity and heterogeneity in mind, we selected eight study sites (Figure 1) based on biological characteristics, historical sampling gaps, ecosystem vulnerability, and logistical concerns. Based on the extent of each site, we sampled in 2-3 study areas within each site:

1. Madhupur National Park (MNP) is an 8,438 hectare deciduous forest. Two study areas were selected to conduct a survey on a pre-designed time interval. Area 1 was the Rasulpur forest region (24°41'25"N, 90° 08'05"E); and Areas 2 was the Jolui forest region (24° 40'36"N, 90°07'35"E).

2. Lawachara National Park (LNP) is a mixed evergreen forest with an area of 1,250 hectares. Three study areas were selected: Area 1 was Kalachara forest region by the Hilltop Forest Rest House (24°19'42"N, 91° 47'07"E); Area 2 was the Khasiapunji (24°19'42"N, 91°46'40"E), one of the two tribal villages in Lawachara National Park; and Area 3 was the Magurchara forest region (24°19'53"N, 91°47'33"E).

3. Jahangirnagar University (JNU) offers a suburban habitat. Three main study areas were selected: Area 1 was the Wildlife Rescue Center situated at the extreme north of the campus (23°52'09"N, 90°15'59"E); Area 2 was situated just behind the Math-Stat building (23° 52'56"N, 90°16'11"E); and Area 3 was the Bangladesh Livestock Research Institute (BLRI) campus (23° 53'21"N, 90°16'39"E) across the Dhaka-Aricha Highway.

4. Comilla Tipperah Hills (CTH) is comprised of partially degraded *sal* forest. Two selected study areas were selected: Area 1 was located at Kotbari (23° 25'06"N, 91°08'38"E), one of the archeological sites in Mainamati-Lalmai hills; and Area 2 was situated within the Lalmai hills (23°21'56"N, 91°07'02"E) next to a local village which is about 2 km south of Area 1.

5. Kaptai National Park (KNP) is a 5,500 hectare mixed evergreen forest declared as a National Park in 1999. Three major study areas were selected: Area 1 was the forested area by the BFIDC Rest House (22°30'41"N, 92°12'36"E); Area 2 was situated in a healthy forest patch (22°28'11"N, 92°13'59"E) just behind the Kaptai Mukh Beat Forest Office; and Area 3 was a forest patch (22°29'51"N, 92°12'38"E) across from the hydroelectric dam.

6. Sundarbans Reserve Forest (SRF) is the world's largest piece of productive mangrove forest and covers 5,770 km^2. Three main study areas were selected: Area 1 was the Karamjol forest region (22°25'21"N, 89° 35'16"E) situated in the northeastern corner; Area 2 was the Supoti area (22°02'40"N, 89°50'00"E) on the bank of the Baleswar River; and Area 3 was the Katka-Kochikhali region (21°51'21"N, 89°49'02"E) in the extreme south-east.

7. Bandarban Hill District (BHD) is a mountainous district. Three study areas were selected: Area 1 was the Hillside Resort compound (22°10'03"N, 92°13'24"E); Area 2 was by a stream (22°10'18"N, 92°13'39"E) directly downhill from the Hillside Resort; and Area 3 was a medium sized, primarily monoculture teak plantation (22°09'53"N, 92°13'18"E).

8. Teknaf Game Reserve (TGR) covers an area of 11,610 hectares. Two study areas were selected for this study: Area 1 was the Mochoni region (20°56'02"N, 92° 15'37"E) by the Game Reserve Information Office; and Area 2 was about 200 m south in a hilly forest (20° 55'38"N, 92°15'16"E).

Of the 187 amphibian and reptiles species known from Bangladesh, we selected 100 (27 amphibians and 73 reptiles; Appendix 1) for the species richness analysis. Due to lack of reliable species distribution records (e.g. data deficient species), we were not able to include all the recorded herpetofaunal species in the analysis. Therefore, species selection was mainly based on the availability of authenticated occurrence records. Species distribution records were primarily collected during the current project; roughly 10% of the occurrence data are based on published literature sources.

Sampling techniques

A combination of sampling techniques was used to determine reptile and amphibian species richness at the selected sampling sites. We primarily used Visual Encounter Surveys (total ~1,200 hours) as the primary sampling technique, supplemented by drift fence arrays with pitfall and funnel traps, standardized road searches, cover-board arrays, auditory surveys, and line transects. A team including the first author and 2-3 field assistants conducted

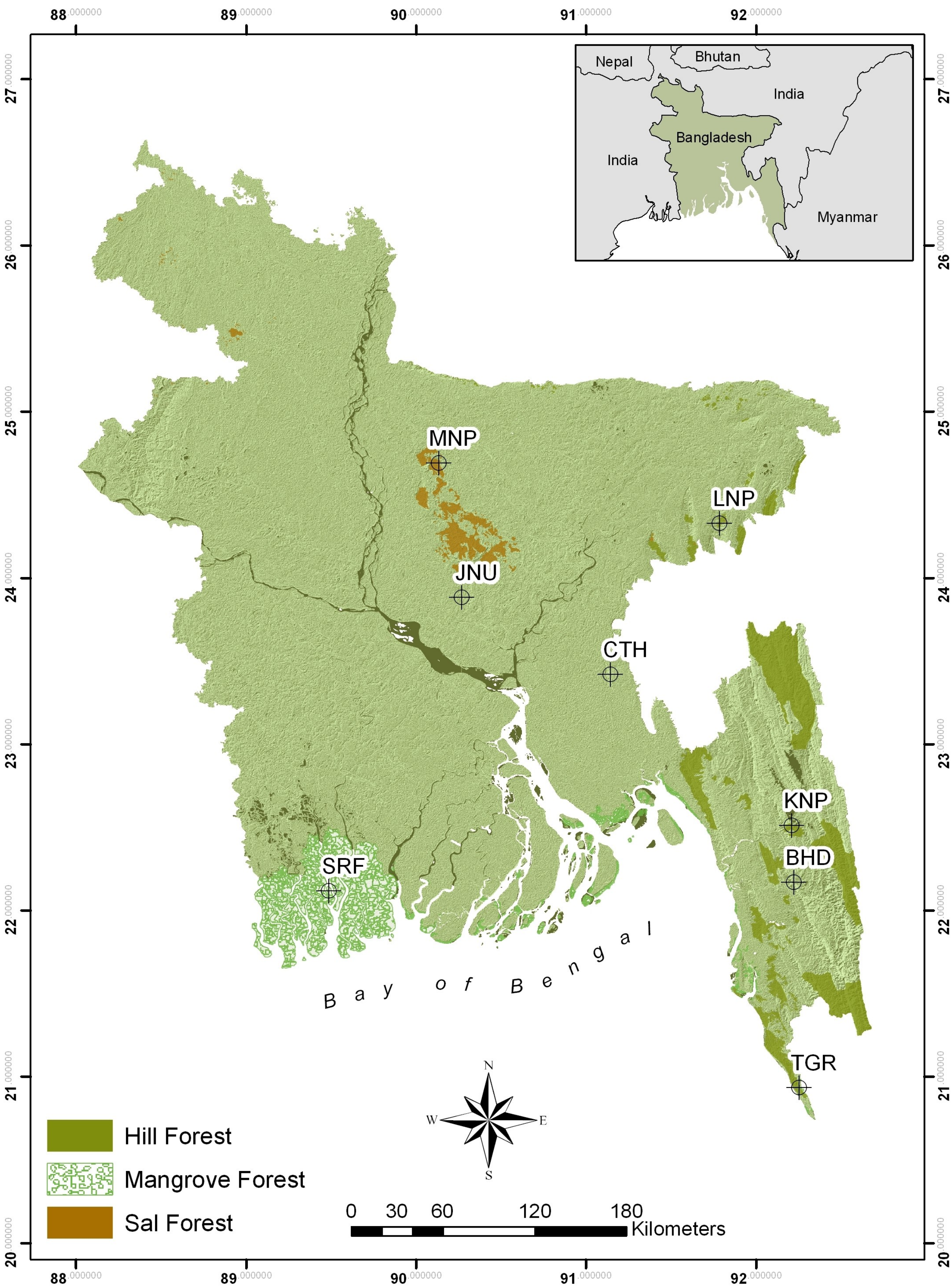

Figure 1. Selected eight study sites in Bangladesh. MNP: Madhupur National Park, LNP: Lawachara National Park, JNU: Jahangirnagar University, CTH: Comilla Tipperah Hills, KNP: Kaptai National Park, SRF: Sundarbans Reserve Forest, BHD: Bandarban Hill District, TGR: Teknaf Game Reserve.

week-long fieldwork at each site during every summer from 2006 to 2009. On a few occasions, the survey team had to conclude fieldwork earlier than the scheduled time because of logistical concerns. To make the survey period at all the study sites uniform and compensate for any missed days, we conducted surveys for extra days during a later season. To account for seasonal variation, we also conducted fieldwork at least once at each study site during the winter seasons of 2008 and 2009. The team spent about 150 hours in each study site, of which about 20% was devoted to night surveys. Road searches and line transect surveys consisted of about 750 km overall and included auditory surveys. As a result of logistical limitations, drift fence arrays were only constructed at Lawachara NP, Kaptai NP, and Madhupur NP, which were thought to harbor more diverse herpetofauna. Each drift fence was equipped with four pitfall traps and two funnel traps which were checked every morning. Cover-board arrays, each comprised of five 75×75×1 cm sheets of plywood/hardboards arranged in a diamond formation, were only used at two study sites (Bandarban HD and Jahangirnagar University) during one summer and were checked every other day for two weeks. They proved to be ineffective and their use was discontinued.

Analyses

The number of observed species, S_{obs} is the "total number of species observed in the pooled number of samples" and S_{est} is the "estimated species richness, where $_{est}$ is replaced by the name of the estimator" (Colwell *et al.,* 2004). We calculated S_{est} using the freely available EstimateS Version 8.2.0 software (Colwell, 2009) using)the presence/absence (occurrence data for each species in each sample. All recorded data for each species were pooled regardless of sampling technique or timing of observation, and S_{est} was calculated for all species combined as well as for individual taxonomic groups. We performed a Student t-test to compare the observed species richness values (S_{est}) among eight study sites with a null hypothesis of equal mean richness values across study sites. Due to the fact that the true species richness (S_{true}) can hardly be determined in highly diverse communities, we used a surrogate richness variable, S_{true*} which was measured as the arithmetic mean of the five most popular non-parametric estimators (ACE, ICE, Chao1, Jacknife 1, and Bootstrap, each calculated using 500 randomizations with replacement) at each study site (Brose, 2002). The accuracy of the five estimators was measured by relative bias as the ratio of S_{est} to S_{true*}, i.e. percent of true richness (PTR): PTR [%] = (S_{est}/S_{true*}) *100. The closer PTR is to 100% the more accurate is the estimator. PTR will be above 100% if the estimator overestimates and below 100% if the estimator underestimates S_{true*}. Precision was measured as the standard deviation of the PTR, with lower standard deviations interpreted as indicating higher precision (Brose, 2002). A one-way ANOVA was conducted to compare the performances of the five selected species richness estimators. A Tukey's multiple comparison test was conducted to identify which species richness estimators were significantly different from the other. To compare species compositions among different study sites we derived Chao-Jaccard Similarity Indexes (JSI) using 500 randomizations, with replacement, from X-matrices of initial detection data.

RESULTS

Of the 938 capture records, the highest number of individuals was from Lawachara NP (n = 170), whereas the lowest number was found in Comilla TH (n = 52). The overall observed species richness (S_{obs}) and estimated species richness (S_{est}, all five estimators) varied significantly among the study sites. The observed species richness (S_{obs}) ranged between 23 and 71 species (Table 1). Although the highest capture of individuals occurred in the LNP, herpetofaunal species richness was highest at LNP, with Kaptai NP close behind, the highest number of observed species richness (Sobs) was found at KNP.

Table 1. Amphibian, reptile, and total herpetofaunal observed species richness (S_{obs}) and surrogate richness variable (arithmetic mean of the five species richness estimators, S_{true*}) for the selected eight study sites in Bangladesh based on the fieldwork conducted between 2006 and 2009. CTH: Comilla Tipperah Hills; JNU: Jahangirnagar University; MNP: Madhupur National Park; TGR: Teknaf Game Reserve; SRF: Sundarbans Reserved Forest; BHD: Bandarban Hill District; LNP: Lawachara National Park; and KNP: Kaptai National Park.

	Observed Species Richness (S_{obs})			Surrogate Richness Variable (S_{true*})		
	Amphibians	Reptiles	Total Herps	Amphibians	Reptiles	Total Herps
CTH	8	15	23	15	38	53
JNU	11	20	31	22	42	64
MNP	13	33	46	20	53	73
TGR	11	38	49	18	64	82
SRF	12	43	55	17	73	90
BHD	17	46	62	23	74	97
LNP	16	52	68	26	75	101
KNP	19	52	71	28	80	108

The lowest S_{obs} was again recorded from Comilla TH. Capture records represented 100 species, 27 amphibians and 73 reptiles, and estimates of overall herpetofaunal species diversity were primarily influenced by the diversity of reptiles. The value of surrogate richness variables (S_{true*}, arithmetic mean of the five estimators) were always much higher than the observed species richness (S_{obs}) for all study sites (Table 1).

The five species richness estimators (S_{est}) were overall significantly different (one way ANOVA; df = 5, p = 0.0051).The $S_{Chao\ 1}$ estimator produced the most accurate and precise result, whereas S_{ICE} estimator performed precisely, but overestimated the overall species richness value for all the study sites (Figure 2). Chao-Jaccard Indices of herpetofaunal overlap between site pairs varied between 0.41 and 0.78 (mean = 0.61; Table 2), indicating that species compositions were generally not similar among sites.

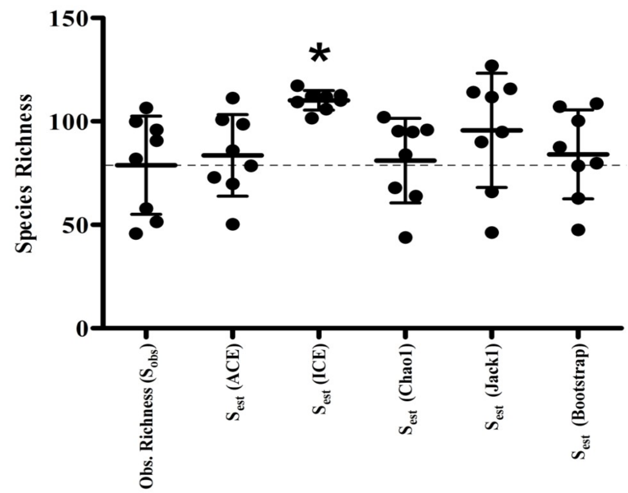

Figure 2. Observed species richness (S_{obs}) and different nonparametric species richness estimators derived from program EstimateS. Each within figure represents species richness values in each site. Outputs from five nonparametric species richness estimators have been compared with S_{obs}, which are significantly different (one -way ANOVA and Tukey's multiple comparison test; p = 0.0051, df = 5, F = 3.946). * indicates that the S_{est} (ICE) estimates is significantly different from all others.

DISCUSSION

Observed (S_{obs}) and surrogate richness variables (S_{true*}) for herpetofaunal species richness values revealed that the Kaptai and Lawachara National Parks are the most herpetologically diverse sites we examined. The consistent high value for surrogate richness variables (S_{true*}) for all study sites indicate that there are more species in each study sites than actually discovered. The unequal detection probabilities as well as sampling inadequacy have already been discussed earlier for the underestimated observed species richness of the study sites (Colwell and Coddington 1994; Chao *et al.,* 2000; Brose *et al.,* 2003). Therefore, care should be taken when using the surrogate richness variable (S_{true*}) value for habitat management practices.

Table 2. Chao-Jaccard similarity indexes (JSI) for comparisons for the species assemblages among the eight study sites in Bangladesh [percentile similarity indices of species composition across study sites]. Site abbreviations are as in Table 1.

Study Sites	JNU	MNP	TGR	SRF	BHD	LNP	KNP
CTH	0.70	0.67	0.55	0.41	0.52	0.45	0.44
JNU		0.70	0.65	0.70	0.58	0.50	0.55
MNP			0.67	0.56	0.69	0.63	0.62
TGR				0.59	0.71	0.62	0.70
SRF					0.53	0.54	0.61
BHD						0.74	0.76
LNP							0.78

The highly diverse Kaptai and Lawachara National Parks are among the 19 'Protected Areas' of the country (FD 2011) and considered among the best managed forests in Bangladesh. The Lawachara NP has highly diverse plant community (Muzaffar *et al.,* 2007) with the geographic location in the country's highest rainfall (~3000 mm; Nishat *et al.,* 2002). On the other hand, Kaptai NP is located in the remote southeastern part of the country below Rangamati, one of the three true mountainous districts of Bangladesh. It also is considered to be the biodiversity rich region in Bangladesh (Reza, 2014).

Three of the eight sites we sampled stand out as having especially high diversity of both amphibians and reptiles: Kaptai NP, Lawachara NP, and Bandarban HD. Though Madhupur NP is not very species rich in terms of the number of species, the park supports several unique species (e.g., *Kalophrynus interlineatus*, *Kaloula taprobanica*) that are not found anywhere else in the country. Those four sites act as major refuges for amphibian and reptiles species and should be given highest priority for herpetofaunal conservation efforts.

Geographically, the present distribution data show that herpetofaunal diversity is highest in the south-eastern mountainous areas (Chittagong Hill Tracts) and a part of the north-eastern hilly evergreen forest (greater Sylhet region). Chittagong Hills Tract is the largest continuous piece of land, harbours the highest number of herpetofaunal species, has the lowest population density in Bangladesh, and has the lowest risk of natural hazards (e.g. flash and/or seasonal flood, tropical storm; MOEF 2008). This area is arguably the best location to initiate further research and conservation activities for amphibians and reptiles in Bangladesh.

Our findings not only have implications for conservation action in Bangladesh but also provide broader lessons. Perhaps the most important is that using species richness alone when comparing habitat-specific species assemblages lead to interesting conclusions. Similarly, care must be taken when using relative abundances to compare species assemblages (van Horne 1983; Cao *et al.,* 2002). Similarity indices such as the Chao-Jaccard Similarity Indexes compare the composition of assemblages based on the number of shared and unique species, are often resistant to undersampling because they primarily rely on abundant species, and are less likely to be strongly affected by the presence of any particular species (Chao *et al.,* 2005). Given the inability of most studies to sample adequately (Cao *et al.,* 2002), this is a strong argument for the use of such indices. In our study, the three sites containing the most species also had the highest similarity in species assemblages, sharing about 75% of species.

Following the 'hot spot' approach (Myers *et al.,* 2000) that also emphasizes uniqueness allows us identify Madhupur NP as a high priority for herpetological conservation, even though it has fewer species than the top three. Of course, conservation decisions are made not only based on a single taxonomic group. For example, even though the Sundarbans RF has relatively few amphibians and reptiles, it is of great value for other species such as tigers (Reza *et al.,* 2004) and harbors other important species (e.g. *Crocodylus porosus*, *Ophiophagus hannah*). However, studies such as this one provide tools that can be used to compare broader taxonomic assemblages when making conservation priorities. Countries such as Bangladesh, which suffer from growing population pressures and continuing poverty, need such tools in order to maximize the benefit gained from investment in land set-asides and their long-term financing.

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Appendix 1. Distribution records of amphibians and reptiles in the selected eight study sites in Bangladesh. CTH: Comilla Tipperah Hills; JNU: Jahangirnagar University; MNP: Madhupur National Park; TGR: Teknaf Game Reserve; SRF: Sundarbans Reserved Forest; BHD: Bandarban Hill District; LNP: Lawachara National Park; and KNP: Kaptai National Park.

Species	CTH	JNU	TGR	SRF	MNP	LNP	BHD	KNP
Amphibians								
Bufo stomaticus	-	√	-	[1,2]	-	-	-	-
Clinotarsus alticola	-	-	[2]	-	-	√	-	√
Duttaphrynus melanostictus	√	√	√	√[1,3]	√[3]	√[2]	√[3]	√
Euphlyctis cyanophlyctis	√	√	√	√	√	√	√	√
Euphlyctis hexadactylus	-	√[3]	-	√[1,3]	-	-	-	-
Fejervarya cancrivora	-	-	-	√[4]	-	-	-	-
Fejervarya limnocharis	√	√	√	√	√	√	√	√
Fejervarya syhadrensis	-	-	-	-	-	-	[3]	[3]
Hoplobatrachus crassus	-	√	-	√[2,3]	√[3]	-	√	√
Hoplobatrachus tigerinus	√	√	√	√	√	√	√	√
Hylarana leptoglossa	√	-	√	-	√	√	√[5]	√
Ingerana borealis	-	-	-	-	-	-	√	√
Kalophrynus interlineatus	-	-	-	-	√	-	-	-
Kaloula pulchra	-	-	-	-	-	√	√[5]	-
Kaloula taprobanica	-	-	-	-	√	-	-	-
Leptobrachium smithi	-	-	√[2]	-	-	√	√[3]	√
Limnonectes laticeps	-	-	-	-	-	-	-	√
Limnonectes limnocharis	√	√	√	√	√	√	√	√
Microhyla berdmorei	√	-	√	-	√	√	√[5]	√
Microhyla ornate	√	√	√	√	√	√	√	√
Microhyla rubra	-	-	-	√	-	√[2]	-	√
Micryletta sp.	-	-	-	-	-	√	-	-
Occidozyga lima	-	-	√[6]	-	-	-	-	√
Polypedates leucomystax	√	√	√	√	√	√	√	√
Rhacophorus bipunctatus	-	-	-	-	-	√	-	[7]
Uperodon globulosus	-	√	-	-	√	-	√	-
Xenophrys parva	-	-	-	-	-	-	√[5]	√
Reptiles								
Ahaetulla nasutus	-	-	[2, 3]	√	[2]	√[2]	√	[2, 3]
Ahaetulla prasina	-	-	-	√[2]	-	-	√	[2]
Amphiesma stolata	-	√[3]	√	√	√[3]	√[3]	√	√
Amphiesma venningi	-	-	-	-	-	-	-	√
Amphiesma xenura	-	-	-	-	-	-	√[3]	√
Batagur baska	-	-	-	-	[8]	-	-	-
Boiga cyanea	-	-	[2, 3]	[2]	-	[2, 3]	[2]	√
Boiga ochracea	-	-	-	[1]	-	-	√[3]	-
Bungarus fasciatus	-	-	[1]	-	√	√	[1,3]	-
Calliophis melanurus	-	-	[3]	[10]	-	[3]	-	[3]
Calotes emma	-	-	-	-	-	√	[3]	√
Calotes versicolor	√	√	√	√	√	√	√	√
Cerberus rynchops	-	-	√[2, 3]	√	-	-	-	-
Chrysopelea ornate	-	√[1, 2]	√[3]	√	-	√[3]	√	√
Coelognathus radiates	-	-	-	-	-	√	√	[3]
Crocodylus porosus	-	-	-	-	√[1, 2, 3]	-	-	-
Cryptelytrops albolabris	-	-	-	√	[2, 3]	√	[3]	√[2]
Cryptelytrops erythrurus	-	-	-	-	[2]	[3]	√	[3]
Cyclemis oldhamii	-	-	-	-	-	-	[1, 9]	[1, 9]
Cyrtodactylus ayeyarwadyensis	-	-	-	√	-	√	√[11]	√[11]
Dendrelaphis pictus	-	[1]	[2, 3]	√	√[3]	√[2, 3]	√	√[3]
Dendrelaphis tristis	[3]	[1, 3]	[3]	√	√	√	√	[3]
Draco maculates	-	-	-	-	-	√	√	√
Enhydris enhydris	-	√	√	√	-	√[3]	√	√
Eutropis carinata	√	√	√	√	√	√	√	√
Eutropis multifasciata	-	-	-	-	√	-	-	-
Eutropis macularia	√	√	√	√	√	√	√	√
Gekko gecko	√	√	√	√	√	√	√	√
Gerardia prevostianus	-	-	√	√[3]	-	-	-	-

Species	CTH	JNU	TGR	SRF	MNP	LNP	BHD	KNP
Hemidactylus bowringii	√	√	√	√	√	√	√	√
Hemidactylus brookii	√	√	√	√	√	√	√	√
Hemidactylus flaviviridis	√	√	√	√	√	√	√	√
Hemidactylus frenatus	√	√	√	√	√	√	√	√
Hemidactylus garnotii	-	-	-	-	-	√	-	-
Hemidactylus platyurus	-	-	-	√	-	√	√	-
Indotestudo elongate	-	-	-	-	-	√	√	[3]
Lissemys punctata	-	√	√	√	√	√	√	√
Lycodon aulicus	√	-	[3]	[2, 3]	√[3]	√	√[3]	[2, 3]
Lycodon jara	-	-	-	[2]	√	√	√	[3]
Lycodon zawi	-	-	-	-	-	-	√	-
Lygosoma bowringii	√	-	√[3]	-	√	√[3]	-	-
Lygosoma lineolatum	-	-	-	-	-	√	-	-
Lygosoma punctata	√	-	√[2]	-	-	-	√	√
Melanochelys trijuga	-	-	-	√	-	-	-	-
Morenia petersi	-	-	-	√	-	-	-	√
Naja kaouthia	-	-	[2, 3]	√[3]	√	√	√	√
Naja naja	[3]	√	[1, 2]	[2, 3]	√[2]	√[2]	√	√[2, 3]
Nilssonia gangeticus	-	-	-	√	-	-	-	√
Nilssonia hurum	-	-	-	√	-	-	-	√
Nilssonia nigricans	-	-	-	-	-	-	-	√[*]
Oligodon dorsalis	-	-	[1]	-	√	√[3]	[1]	√
Oligodon taeniolata	-	√	-	√[3]	√	√	√	[3]
Ophiophagus hannah	-	-	-	-	√	-	-	-
Pareas monticola	-	-	-	-	-	-	√	√
Pangshura tectum	-	-	-	√	-	-	-	√
Pangshura tentoria	[3]	-	-	-	-	-	-	√
Psammodynastes pulverulentus	-	-	-	-	-	-	√	√
Ptyas korros	-	-	[2]	[2]	-	[2]	-	[2]
Ptyas mucosa	√[3]	√[3]	√[3]	√[3]	√[3]	√[3]	√[3]	√[3]
Ptyctolaemus gularis	-	-	-	-	-	-	√	√
Python molurus	-	-	-	√	-	√	√	[3]
Python reticulates	-	-	-	-	-	-	-	√
Ramphotyphlops braminus	-	-	-	-	-	√	√	√
Rhabdophis subminiatus	-	-	[3]	-	√	-	√[3]	√[3]
Sphenomorphus maculates	-	-	√[2]	-	√	√[2]	√	√[2]
Takydromus khasiensis	-	-	-	-	-	-	[2, 3]	-
Typhlops diardii	-	√	√	√	√[2]	[2]	-	-
Typhlops jerdoni	√	√	[2, 3]	[2, 3]	√[3]	√[2, 3]	√	√[1, 2]
Varanus bengalensis	√[3]	√[3]	√[2, 3]	√[2, 3]	√[2, 3]	√[2, 3]	√[3]	√[2, 3]
Varanus flavescens	-	-	√	-	√	-	-	-
Varanus salvator	-	-	-	-	√[2, 3]	-	-	-

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