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RAT EATER AND NON-RAT EATER SPECIES KILLED BY THE PEOPLE DURING THE RODENT OUTBREAKS: AN ASSESSMENT IN RUMA UPAZILA OF BANDARBAN HILL DISTRICT

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Key words: Rat eater and non-rat eater, Wild animal, Consumption, Conservation, Bamboo flowering, Rodent outbreaks

Abstract

An assessment was done to assess the intensity of rat eater and non-rat eaters' species killed by the people during the rodent outbreaks in association with *Melocanna baccifera* bamboo flowering in the village of Basatlang, Neweden, Munlai, Mualpi and Ruma sadar market area of Ruma upazila of Bandarban district. The other objectives of the study were to support the future control of rodent outbreaks and conservation of wild animal species. A structured data sheet was used to record the hunted rat eater and non-rat eaters' data from June 2009 to December 2012. Shannon-Wiener's diversity index and Simpson's diversity index were also calculated to assess the diversity of rat eaters and non-rat eater species. The study revealed that a total of 628 numbers of hunted rat eater and non-rat eater animals (average 14.60 numbers per month) recorded with 41 species. Of them, 12 species of mammals, 11 species of reptiles and 18 species of Aves. The overall hunted rat eater and non-rat eater diversity indices were 2.59 for Shannon-Wiener's diversity index, and 0.82 for Simpson's diversity index that indicate high species diversity. Irrawaddy squirrel, Tokay gecko, wild boar, deer and red-vented Bulbul were the top five hunted non-rat eater species. Domestic dog, monitor lizard, jungle cat, domestic cat and striped keelback snake were the top five rat eater species hunted by the people. Consumption and economic return were the main reasons for hunting the animals. These findings can be used to raise public awareness along with application of Wildlife (Conservation and Security) Act, 2012 to stop killing of rat eater and non-rat eater species during the rodent outbreaks and non-outbreaks period in the study areas, and elsewhere in Chattogram Hill Districts.

Introduction

Chattogram Hill Tracts (CHT) comprises of three hill districts of Bandarban, Khagrachari and Rangamati which is rich in biodiversity in terms of flora and fauna as well as ethnic diversity. The area (13,294 km^2) covers about 40% natural forests(1) that

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presents nearly 80% of total biodiversity in the country[2,3]. The notable forest products are Garjan (*Dipterocarpus turbinatus*), Chapalish (*Artocarpus chama*), Teak (*Tectona grandis*), Gamar (*Gmelina arborea*), Dhakaijam (*Syzygium grande*), Shimul (*Bombax ceiba*), Mahogany (*Swietenia macrophylla*), Koroi (*Albizia* spp.), bamboos, and numerous non-timber forest products[4,5]. In addition, wild animal is one of the important resources in CHT that includes wild boar (*Sus scrofa*), golden cat (*Felis temminki*), dhole (*Cuon alpinus*), sambar deer (*Rusa unicolor*), gaur (*Bos gaurus*), red serow (*Capricornis rubidus)* barking deer, (*Muntiacus vaginalis*), clouded leopard (*Neofelis nebulosa*), and leopard (*Panthera pardus*)[6].

Forests and wildlife resources play an important role in the development of livelihoods of the rural people in terms of food security, medicine, shelter, energy and economic return[7]. Majority of the rural people are dependent on biodiversity in terms of collection and consumption of forests products, and hunting of wild animals[8,9] . In Bangladesh, about 64% of total population are involved in collecting tree and forests products for their livelihood[10]. In CHT, about 46% income is derived from the forest resources[11,12].

People hunt or kill the wild animals in various reasons, and is one the main concerns of declining of wild animals in Bangladesh[13]. Consumption, economic return from selling of wild animals and its parts, and damage to the human life and crops, loss of humans were the main reasons for killing and hunting of wildlife[14,15]. Hunting of wildlife was also reported during the coronavirus disease 2019 (COVID-19) pandemic. In this document, hunting refers to "killing, capturing, poisoning of any wild animal or any attempt to do so" according to the Wildlife (Conservation and Security) Act 2012[16]. A review study conducted by Islam[17]reported that a total of 561 wildlife had been killed in Bangladesh during COVID-19 pandemic from 1st January to 30th June 2020. Of them, 87.5% were birds, followed by *Rhesus macaque (*2.9%), Asian elephant (2.1%), Indian spotted deer (2.0%), Asian palm civet (1.2%), golden jackal (1.6%), fishing cat (0.9%), jungle cat (0.7%), small Indian mongoose (0.7%), and others (0.4%).

In CHT, from 2006 to 2010, rodent outbreaks followed by *Melocanna baccifera* (*Muli bansh*) flowering and seed mastings had a significantly impact on people's livelihood where farmers lost their crops and household assets[18, 19]. Different institutions assessed the impacts of rodent outbreaks in terms of food security, nutrition, health conditions, crop damage assessment of the affected people[20,21,22], but very few approaches have been carried out control of rodent damage to protect the crops and households asset. It has been stated that biological control (predator animals,) of rodent population can reduce the impact of rodent attack to the farmer's crops[23]. The predatory animals such as the mongoose (*Herpestes auropunctatus*), the ferret (*Putorius putorius*), domestic and feral cats (*Felis catus*), and the monitor lizard (*Varanus indicus*), have been used to control the rodent populations[24]. Reduction of rodent activity was also observed in the homestead when cats and dogs were present[25].

Currently, there is no research on animals hunting (rat and mice predators) during the rodent outbreaks in association with *Melocanna baccifera* bamboo flowering and fruiting in CHT and other parts of the country. Thus a quantitative assessment of hunted rat eater and non-rat eater species during the rodent outbreaks was important to support future biological control of rodents (mainly rats and mice) along with other management approaches related to *Melcoanna baccifera* bamboo flowering and fruiting. The findings of the study could be a baseline information to monitor the animal (wild) hunting, diversity of animal hunting and reasons for hunting in the study areas. In addition to this, the results can contribute to undertake appropriate measures for the conservation and protection of endangered wild animals' species in Bandarban hill district and other CHT districts.

Materials and Methods

Study area: The study was conducted in the village of Neweden, Munlai, Basatlang, Mualpi and Ruma sadar upazila bazaar (market) area in Ruma upazila (Fig. 1). Ruma is one of remote upazila's of Bandarban hill district that covers 492.09 square kilometre (sq.km) area with low population density (59 per sq. km), and about 92% households represent ethnic minority. Marma, Mro, Tripura and Bawm are the main ethnic community. Majority of the households live in rural areas (77.39%) than urban area (22.61%). About 75% households are dependent on agriculture for their livelihoods, and 99% of agricultural lands are high land. Paddy, cotton, maize, turmeric, ginger, vegetables are the main crops. Banana, pineapple, jackfruit, orange, papaya and mango are the main fruits of this upazila. The Annual temperature (14.9 to 27°C) and rainfall 4,411 millimetre in the year of 2011[26]. Ruma was selected for the study due to presence of bamboo flowering, and is one of the severely rodent affected areas in CHT.

Data collection process and tools: A step wise procedure was adopted to assess the status of hunted rat eater and non-rat eaters' species in the study areas as this research was a part of main research focuses on rodent population outbreaks in relation to the bamboo flowering in Ruma upazila. Before initiating the study, a group meeting with the villagers was held in each selected village and informed the objectives of the research. To execute the study, five field staffs (having minimum secondary school certificate (SSC) level education) were recruited from each selected village. Prior to data collection, a day-long training session was provided to the staffs on research objectives, and recording the required information using the structured open ended data sheet (questions/variables) which includes date, hunted animals name, number of hunting individuals, hunting area, reasons for hunting, and market price (if any) of the individual animal, type of animals. In addition, status of wild animals and most hunted species in the locality, Bengali name of the wild animals, and rodent (mainly rats and mice) predatory animals were discussed with photographs for species identification. After the training, printed colour important

CHT wild animal photographs with Bengali and English names (sources: Banglapedia: National Encyclopaedia of Bangladesh- https://www.banglapedia.org/, online database at Animal Diversity Web-https://animaldiversity.org/ and Google) were supplied to the field staffs to support for identification of rat eaters and non-rat eater species. In addition, red book of threatened mammals, birds, amphibians and reptiles of Bangladesh were used for species identification[27,28,29].

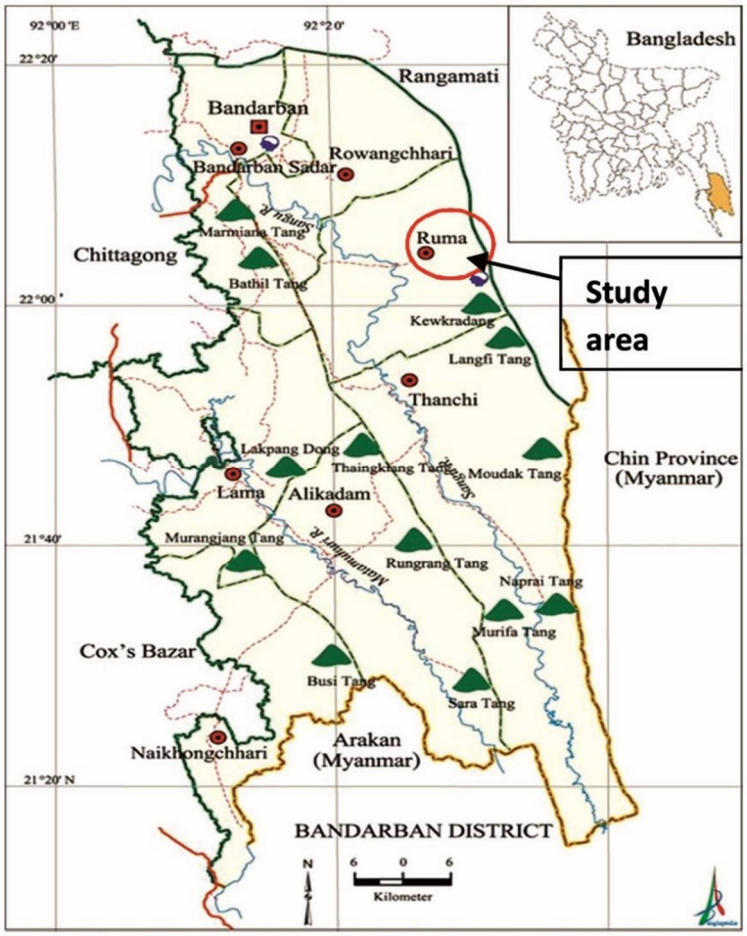

Fig. 1. Map of Bandarban district and circle denotes the study site in Ruma upazila (Source: Banglapedia).

Data collection of hunted species in the study areas: Trained field assistants were employed to record the already hunted species information in the study area. As the field staffs were from the study areas, it was possible for them to gather data on daily hunting records. Respective villagers/hunters were interviewing for information about the

hunting species during the study period from June 2009 to December 2012 (3 years and 7 months). As our main objective was to assess the hunting of rat eaters and non-rat eaters in the study area, therefore we did not perform household interview through random sampling rather collected daily hunted data from those (hunters) involved in hunting and related activities (capturing/trapping). That means, we collected data from the respondents or hunters whenever they were involved in hunting activities during the study period. We recorded only hunted animals of Mammals (excluding rats and mice), Reptiles and Aves in the data sheet based on research objectives. Intentionally, Amphibians, Fishes and other invertebrates were not considered in the study.

Identification of hunted rat eater and non-rat eaters' species: We identified the hunted species by observing the physical characteristics/features in the respective villages along with using the source materials such as red books and printed colour photographs of species. In addition, we took photographs of the hunted species when possible for further confirmation and identified consultation with wildlife biologist. When there were no physical objects of the hunted species, we relied on hunters physical descriptions of the species. In this case, the hunters provided the local name and the physical description of the hunted species. Then, we identified the species by showing the printed colour photographs. For identification of rat eater and non-rat eaters' species we mainly relied on secondary literatures that includes published books, reports and internet as mentioned at data collection process and tools section. Hunters or respondents perception were also considered for identifying the rat eater and non-rat eater species. We did not perform any feeding trails or diet preference experiments for identifying the rat eater and non-rat eater species.

Data entry and data analysis: Recoded data were checked for missing information before data entry. An Excel database was developed for data entry and processed for analysis. Microsoft Excel 2013 and Statistical Package for Social Sciences (SPSS) version 20 were used for data analysis. Quantitative information such as number of rat eater and non-rat eater species were presented in percentages and mean values ± standard error of the mean. Analysis of variances (ANOVA) was done to understand the significant differences on number of hunted species among years. Differences were considered for significant level at $p< 0.05$. Post hoc with Bonferroni analysis was also performed to understand the significant differences. In addition, Shannon-Wiener's diversity index (*H*)[30] and Simpson's diversity index (*D*)[31] were calculated using the following equations to assess the diversity of rat eaters and non-rat eater species in the study areas.

Shannon-Wiener's diversity index (H) = $- \sum_{i=1}^{n} Pi \times \ln Pi; Pi = n/N$

Simpson's diversity index (D) = $1 - \Sigma (n/N)^2$

Where, n = number of hunted individuals of each species, N = total number of hunted individuals of all species

Results and Discussion

Total numbers of hunted rat eaters and non-rat eaters: In total 628 numbers of hunted rat eaters and non-rat eaters (14.60 numbers per year) recorded from June 2009 to December 2012 in the study area (Table 1). There were significant differences in the number of hunted rat eater and non-rat eaters among years ($F_{3, 215} = 3.542$, $p = 0.015$). Post hoc analysis with Bonferroni revealed that there were significant differences in the numbers of hunted animals between 2010 and 2012 ($p = 0.038$), and between 2011 and 2012 ($p = 0.046$). The highest average number of hunted animals per month found in 2010 (3.33 ± 0.552), followed by 2011 (3.21 ± 0.344), 2009 (3.15 ± 0.408) and 2012 (1.80 ± 1.67). The findings indicated that majority of the hunters involved in hunting of rat eaters and non-rat eaters in 2010. It was observed that hunters used air gun and other bamboo and wood made trapping, and wire made snares for hunting of animals in the study areas.

In terms of monthly hunted individuals, there were no significant differences from 2009 to 2012 ($F_{11, 207} = 1.054$, $p = 0.400$). The Table 1 also shows that numbers of hunted rat eater and non-rat eaters were high during November to February as compared to July to October and March to June. The results indicated hunters preferred to hunting during the dry seasons. The hunters also reported that hunting at dry or winter season was good due to favorable weather condition in the forests and in the crop fields.

Table 1. Monthly total numbers of hunted rat eaters and non-rat eaters' animals recorded from June 2009 to December 2012.

Months	Year wise number of hunted rat eaters and non-rat eaters animals								Total
	2009		2010		2011		2012		
	Non-rat eaters	Rat eaters	Non-rat eaters	Rat eaters	Non-rat eaters	Rat eaters	Non-rat eaters	Rat eaters	
January	-	-	31	-	11	5	10	2	59
February	-	-	19	1	17	3	10	2	52
March	-	-	12	-	11	2	3	1	29
April	-	-	5	2	11	2	4	4	28
May	-	-	2	-	13	2	-	4	21
June	7	5	5	7	13	3	-	3	43
July	-	11	2	5	20	2	-	6	46
August	8	3	15	1	10	3	2	6	48
September	12	10	4	1	21	1	8	3	60
October	18	11	18	2	10	2	6	2	69
November	32	8	15	2	16	2	8	4	87
December	32	13	9	5	14	2	9	2	86
Total	109	61	137	26	167	29	60	39	628

Diversity of hunted rat eater and non-rat eater's species: Out of 628 hunted individuals, mammals (60.19%) represented the highest proportion, followed by reptiles (25.64%) and Aves (14.17%). It also found that 94.75% were wild animals and 5.25% were domestic animals among the total hunted rat eaters and non-rat eaters. At the species level, a total of 41 species were recorded in which 23 were non-rat eater and 18 were rat eater species (Table 2). Overall, hunted rat eater and non-rat eater diversity indices were 2.59 for Shannon-Wiener's diversity index, and 0.82 for Simpson's diversity index that indicate high diversity.

Table 2. Species wise total number of hunted rat eaters and non-rat eaters recorded from 2009 to 2012.

Sl. no.	Local names	English names	Scientific names	Non rat eaters (no.)	Rat eaters (no.)	Total (no.)	IUCN status (BD) in 2015
1.	Ajogor	Indian Python	*Python molurus*		3	3	DD
2.	Badami Kathbirali	Irrawaddy squirrel	*Callosciurus pygerythrus*	243		243	LC
3.	Banor	Rhesus Macaque	*Macaca mulatta*	2		2	VU
4.	Bhat Shalik	Common Myna	*Acridotheres tristis*	3		3	LC
5.	Biral	Domestic cat*	*Felis catus*		15	15	--
6.	Bon Biral	Jungle cat	*Felis chaus*		16	16	NT
7.	Bon Murak	Jungle fowl	*Gallus gallus*	4		4	LC
8.	Bulbul	Red-vented Bulbul	*Pycnonotus cafer*	10		10	LC
9.	Buno Shukar	Wild boar	*Sus scrofa*	53		53	LC
10.	Machhranga	Common Kingfisher	*Alcedo atthis*	7		7	LC
11.	Darash Shap	Indian Rat Snake	*Ptyas mucosa*		9	9	LC
12.	Dhanes parki	Oriental pied-hornbill	*Anthracoceros albirostris*	3		3	LC
13.	Doel	Oriental Magpie-Robin	*Copsychus saularis*	3		3	LC
14.	Dora Shap	Striped Keelback, Buff Striped Keelback	*Amphiesma stolatum*		13	13	LC
15.	Dudhraj Shap	Copper-head Trinket Snake	*Coelognathus radiatus*		7	7	NT
16.	Gui Shap	Monitor lizard	*Varanus bengalensis*		18	18	NT
17.	Halud Khonjan	Yellow Wagtail	*Motacilla flava*	3		3	LC
18.	Holdey Pakhi	Black-headed Oriole	*Oriolus xanthornus*	6		6	LC
19.	Kalo Bhalluk	Asiatic Black Bear	*Ursus thibetanus*	1		1	CR
20.	Kalo Kokil	Brainfever Bird	*Hierococcyx varius*	6		6	LC
21.	Kani or Kana Bok	Pond heron	*Ardeola grayii*	4		4	LC

Table 2 contd.

Sl. no.	Local names	English names	Scientific names	Non rat eaters (no.)	Rat eaters (no.)	Total (no.)	IUCN status (BD) in 2015
22.	Kat thokra	Heart-spotted woodpecker,	*Hemicircus canente*	6		6	DD
23.	Ghughu	Eurasian Collared Dove	*Streptopelia decaocto*	6		6	LC
24.	Kukur	Domestic dog*	*Canis lupus familiaris*		18	18	--
25.	Lojjaboti Banor	Slow loris	*Nycticebus bengalensis*	1		1	EN
26.	Lokkhi Pecha	Barn owl	*Tyto alba*		4	4	LC
27.	Maya Harin	Barking Deer	*Muntiacus muntjak*	21		21	EN
28.	Mechho Biral	Fishing Cat	*Prionailurus viverrinus*		1	1	EN
28.	Pahari Shikre-eegol	Mountain Hawk-eagle	*Nisaetus nipalensis*		3	3	VU
30.	Raj Gokra, Hala Jamuro	King Cobra	*Ophiophagus hannah*		1	1	VU
31.	Sabuj Darash Shap	Green Rat snake	*Ptyas nigromarginata*		7	7	VU
32.	Shabuj Bora	Green Pit Viper	*Trimeresurus albolabris*		10	10	LC
33.	Shadharaon Geso Shap	Common Bronzeback Tree Snake	*Dendrelaphis tristis*		11	11	LC
34.	Shial	Golden Jackal	*Canis aureus*		4	4	LC
35.	Shojaru	Indian Porcupine	*Hystrix indica*	3		3	LC
36.	Shonkho Chil	Brahminy Kite	*Haliastur indus*		3	3	LC
37.	Sutanali Shap	Common vine Snake	*Ahaetulla nasuta*		12	12	LC
38.	Tia	Rose-ringed Parakeet	*Psittacula krameri*	7		7	LC
39.	Tila Ghughu	Spotted Dove	*Spilopelia chinensis*	3		3	LC
40.	Tokkhak	Tokay Gecko	*Gekko gecko*	70		70	LC
41.	Tuntuni	Tailor bird	*Orthotomus sutorius*	8		8	LC
			Total	**473**	**155**	**628**	

CR-Critically Endangered, EN-Endangered, VU-Vulnerable, NT-Near Threatened, LC-Least Concern, DD-Data Deficient, *Domestic Animal.

The Table 2 shows that top five hunted species were Irrawaddy squirrel (51.37%), Tokay gecko (14.80%), wild boar (11.21%), barking deer (4.44%) and red-vented Bulbul (2.11%) among the hunted non-rat eater species,. The non-rat eaters' species diversity indices were 1.83 for Shannon-Wiener's diversity index, and 0.70 for Simpson's diversity index. In terms of hunted rat eater species, top five species were monitor lizard (11.61%), domestic dog (11.61%), jungle cat (10.32%), domestic cat (9.68%) and striped keelback

(8.39%). The rat eaters' species diversity indices were 2.66 for Shannon-Wiener's diversity index, and 0.92 for Simpson's diversity index. The findings indicated that villagers or hunters hunted a variety of species, and hunted rat eaters species diversity was high as compared to non-rat eater species.

The Table 2 also presents critically endangered and endangered species killed by hunters in the study areas. The notable hunted critically endangered species was Asiatic Black Bear (*Ursus thibetanus*) as per IUCN Bangladesh, 2015 but this listed endangered category in IUCN Bangladesh 2000. The other hunted endangered species were Slow loris (*Nycticebus bengalensis*) but listed as critically endangered in 2000 IUCN Bangladesh, Barking Deer (*Muntiacus muntjak*) and Fishing Cat (*Prionailurus viverrinus*). The Indian Porcupine (*Hystrix indica*) and Indian Python (*Python molurus*) listed as endangered in Bangladesh during 2000 but listed as least Concern (LC) ver 3.1 and Data Deficient (DD) ver 3.1 respectively in 2015 assessment[32]. This results suggested to undertake awareness raising activities with the local people to stop hunting of wild animals' in particular critically endangered and endangered species along with application of Wildlife (Conservation and Security) Act, 2012 in the study areas.

Reasons for killing or hunting of the animals: The main reason for hunting of animals was consumption, followed by cash and consumption, only cash and avoid biting (Fig. 2). During the data collection, hunter/villagers reported that protection of agricultural crops and economic return from selling of skin of the animals were also intensified for the hunting of animals such as python, wild boar and squirrels. Majority of the hunted animals were not marketed so that price of those species were unknown. Table 3 presents average selling price of hunted species and its parts in the study areas.

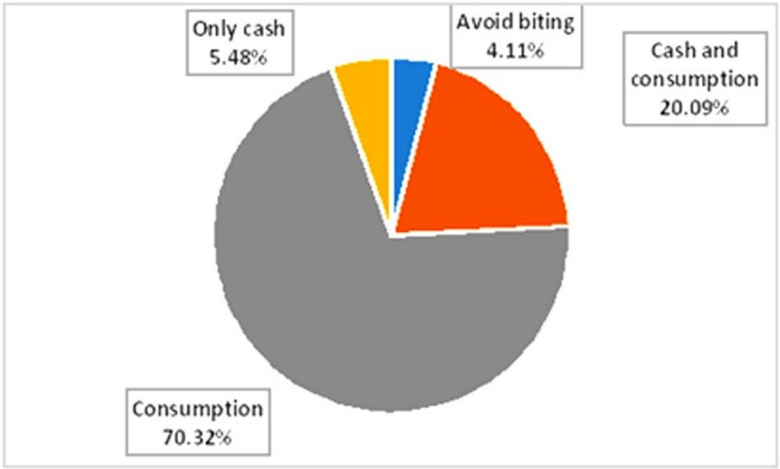

Fig. 2. Proportional distribution of reasons for hunting of rat eaters and non-rat eaters in the study area.

Table 3. Average selling price of the hunted species recorded.

Name of the species	Unit of selling	Average price in Bangladesh Taka (BDT)
Barking deer (*Muntiacus muntjak*)	Per kg	200
Tokay Gecko (*Gekko gecko*)	Per animal	250-300
Monitor lizard (*Varanus bengalensis*)	Per kg	100-150
Indian porcupine (*Hystrix indica*)	Per animal	300
Indian Python (*Python molurus*)	Per skin	2000
Slow loris (*Nycticebus bengalensis*)	Per animal	700
Irrawaddy squirrel (*Callosciurus pygerythrus)*	Per animal	30
Wild boar (*Sus scrofa*)	Per kg	150-200

The study indicated that hunting or killing was high even in the rodent outbreaks for consumption and economic purposes, suggesting food and income generating interventions in the study areas to reduce animals hunting. A study conducted by Chowdhury *et al*.[33] in Bandarban district found that Mro ethnic community hunted 34 species of wildlife from forests, and wild boar was the first preferable for hunting, followed by monitor lizards. The overall diversity of hunted rat eater and non-rat eater species indices were 2.59 for Shannon-Wiener's diversity index, and 0.82 for Simpson's diversity index that indicate high diversity. We found a high diversity of hunted rat eater species as compared to non-rat eater species according to Shannon-Wiener's diversity index, and Simpson's diversity index. In total, we recorded 41 species out of 628 numbers of hunted animals (14.60 numbers per year). Of them, 12 species of mammals, 11 species of reptiles and 18 species of Aves class.

Our study revealed that Irrawaddy squirrel, Tokay gecko, wild boar, barking deer and red-vented Bulbul were the top five non-rat eater hunted species. Monitor lizard, domestic dog, jungle cat, domestic cat and striped keelback were the top five hunted rat eaters' species. Among the hunted species, Asiatic Black Bear was the critically endangered species, and Slow loris, barking deer and fishing cat were the endangered species of the country. In Bangladesh, already 31 species (11 mammals, 19 birds, and one reptile) are regionally extinct[34]. This assessment suggests to address conservation measures and strong implementation of Wildlife (Conservation and Security) Act, 2012 in the study areas for the protection of wild animals species. As this study was a part of main research on assessing rodent outbreaks in relation to bamboo flowering and fruiting, the findings could be a source of information to aware people to stop hunting of rats and mice predatory animals in future rodent outbreaks including non-outbreaks period. Further research is required to assess the effectiveness of biological control of rat and mice during the rodent outbreaks in association with bamboo flowering.

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References

1. Rasul G 2007. Political ecology of the degradation of forest commons in the Chittagong Hill Tracts of Bangladesh. Environmental Conservation. pp. 153-163.
2. Hossain MK 2016. Re-greening the degraded hill forests through recovery and restoration of native tree species, national tree fair, Forest Department, Bangladesh,
3. Jashimuddin M and M Inoue 2012. Management of village common forests in the Chittagong Hill Tracts of Bangladesh: Historical background and current issues in terms of sustainability. Open Journal of Forestry **2**(3):121-137.
4. Chowdhury MA, KN Islam, N Hafiz and K Islam 2019. Diversity of trees in a community managed forest: the case of Komolchori VCF, Khagrachari, Bangladesh. Geology, Ecology, and Landscapes **3**(2): 95-103, DOI:10.1080/24749508.2018.15089
5. Chowdhury B, MK Hossain, MA Hossain and BM Khan 2018. Native tree species diversity of Rampahar natural forest reserve in Rangamati south forest division, Bangladesh. Ceylon Journal of Science **47**(2): 129-136.
6. Chakma S 2017. *Assessment of large mammals of the Chittagong Hill Tracts of Bangladesh with emphasis on tiger (Pantheratigris).*Doctoral dissertation, University of Dhaka.
7. Fisher JA, G Patenaude, K Giri, K Lewis, P Meir, P Pinho and M Williams2014. Understanding the relationships between ecosystem services and poverty alleviation: a conceptual framework. Ecosyst. Serv. **7**: 34–45. https://doi.org/10.1016/j.ecoser. 2013.08.002.
8. Brashares JS, CD Golden, KZ Weinbaum, CB Barrett and GV Okello 2011. Economic and geographic drivers of wildlife consumption in rural Africa. Proceedings of the National Academy of Sciences **108**(34): 13931-13936.
9. Miah D, S Chakma, M Koike and N Muhammed 2012. Contribution of forests to the livelihood of the Chakma community in the Chittagong Hill Tracts of Bangladesh. Journal of Forest Research **17**(6): 449-457.
10. GoB 2019.Tree and forest resources of Bangladesh: Report on the Bangladesh Forest Inventory. Forest Department, Ministry of Environment, Forest and Climate Change, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh. ISBN: 978-984-34-7255-7
11. Rasul G and NBK Tripura 2016. Achieving the sustainable development in the Chittagong Hill Tracts – Challenges and opportunities. ICIMOD Working Paper 2016/12. Kathmandu: ICIMOD.
12. Ahammad R and N Stacey 2016. Forest and agrarian change in the Chittagong Hill Tracts region of Bangladesh. *In*: EL Deakin, M Ksatriya and TCH Sunderland (eds.), *Agrarian Change in Tropical Landscape*. Bogo: Center for International Forests Research (CIFOR), 190-233.

13. Nahar N, M Asaduzzaman, UK Mandal, NA Rimi, ES Gurley, M Rahman and SP Luby2020. Hunting bats for human consumption in Bangladesh. EcoHealth **17**(1): 139-151.
14. Islam MA, M Uddin, MA Aziz, SB Muzaffar, S Chakma, SU Chowdhury and R Akter2013. Status of bears in Bangladesh: going, going, gone?. Ursus **24**(1): 83-90.
15. Chowdhury MSH, S Izumiyama, N Nazia, N Muhammed and M Koike 2014. Dietetic use of wild animals and traditional cultural beliefs in the Mro community of Bangladesh: an insight into biodiversity conservation. Biodiversity DOI: 10.1080/14888386.2014.893201
16. Wildlife (Conservation and Security) Act 2012, Online accessed at //bforest.portal.gov.bd/sites/default/files/files/bforest.portal.gov.bd/page/bcc3e216_3484_4e19_b2fa_5e771b3c3557/Wildlife%20Act%202012.pdf
17. Islam N 2020. Indiscriminate killing of wildlife in Bangladesh during the corona pandemic. Journal of Biodiversity and Conservation, JBC-APRF **4**(4): 405-405.
18. Chakma N, NJ Sarker, SU Sarker, SK Sarker, RB Shafali and SR Belmain 2019. Impact of trap barrier systems on rodent damage to upland rice cropping systems during bamboo masting events. Crop Protection **126**: 104939.
19. Chakma N 2016. *Rodent population outbreaks in relation to bamboo flowering in the Chittagong hill tracts, its impacts on crop production and environment.* Doctoral dissertation, University of Dhaka.
20. Belmain SR, MS Ali, AK Azad, LC Chakma, U Dewan, M Harun, ATM Hasanuzzaman, SMF Islam, MN Kadry, NQ Kamal, NJ Sarker, SK Sarker and SUSarker2008. Scientific assessment report on bamboo flowering, rodent outbreaks and food security: rodent ecology, pest management and socio-economic impact in the Chittagong Hill Tracts, Bangladesh. November 2008. Bangladesh: United Nations Development Programme. At www.nri. org/projects/bandicoot/docs/bamboo.pdf. 50 p.
21. Helen Keller International (HKI) 2008. Food and nutrition survey of two rodent-affected districts in the CHT. Bangladesh: Helen Keller International, for United Nations Development Programme. 22 p. at www.nri.org/projects/bandicoot/docs/HKIsept08.pdf.
22. WFP (World Food Programme) 2011. A rapid food security assessment in Sajek. Vulnerability Analysis and Mapping (VAM) Unit. Online accessed at https://documents.wfp.org/stellent/groups/public/documents/liaison_offices/wfp235250.pdf
23. LabuschagneL, LH Swanepoel, PJ Taylor, SR Belmain and M Keith2016. Are avian predators effective biological control agents for rodent pest management in agricultural systems? BiolControl**101**:94–102.
24. Wodzicki K 1973. Prospects for biological control of rodent populations. Bulletin of the World Health Organization **48**(4): 461.
25. Mahlaba T, AA Monadjem, AR McCleery and SR Belmain2017. Domestic cats and dogs create a landscape of fear for pest rodents around rural homesteads. PloS ONE **12**(2): e0171593.
26. Bangladesh Bureau of Statistics (BBS) 2013. District Statistics 2011: Bandarban. Online accessed at http://203.112.218.65:8008/WebTestApplication/userfiles/Image/District%20Statistics/Bandarban.pdf
27. IUCN Bangladesh 2000. *Red Book of Threatened Mammals of Bangladesh*. IUCN-The World Conservation Union. xii+71 pp
28. IUCN Bangladesh 2000. *Red Book of Threatened birds of Bangladesh*. IUCN-The World Conservation Union.
29. IUCN Bangladesh 2000. *Red Book of Threatened amphibians and reptiles of Bangladesh*. IUCN-The World Conservation Union.

30. Shannon CE and Wiener W 1963. The Mathematical Theory of Communication (127 p). Urbana, IL: University of Illinois Press
31. Simpson EH 1949. Measurement of diversity. Nature **163**(4148): 688-688.
32. IUCN Bangladesh 2015. Red List of Bangladesh Volume 2: Mammals. IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh, pp. xvi+232.
33. Chowdhury MSH, MA Halim, MD Miah, N Muhammed and M Koike 2007. Research communication: biodiversity use through harvesting faunal resources from forests by the Mro tribe in the Chittagong Hill Tracts, Bangladesh. The International Journal of Biodiversity Science and Management **3**(1): 56-62.
34. IUCN Bangladesh 2015. Red List of Bangladesh: A Brief on Assessment Result. Volume 1: IUCN, International Union for Conservation of Nature, Bangladesh Country Office, Dhaka, Bangladesh. pp. 24.

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