Bangladesh J. Zool. ***53****(1): 31-44, 2025* *Article*
ISSN: 0304-9027
eISSN: 2408-8455

ASSESSING ANTHROPOGENIC PRESSURES ON BIRD DIVERSITY IN NIJHUM DWIP NATIONAL PARK, BANGLADESH

Golam Mostafa[1] and Tanzina Alam[2*]

Department of Zoology, Noakhali Science and Technology University
Noakhali- 3814, Bangladesh

ABSTRACT: Nijhum Dwip National Park is a biodiversity-rich coastal ecosystem that plays a crucial role in preserving a variety of plant and animal species. It is made up of a series of islands, primarily covered by mangroves, tidal forests, and mudflats which serve as vital habitat for birds. A study was conducted on the impacts of anthropogenic activities on birds of Nijhum Dwip National Park from October 2023 to March 2024. Studying the impacts of anthropogenic activities on birds of this area is significant for ensuring the long-term health of bird populations, especially migratory species that rely on the diverse ecosystems of the park. A total of 67 species of birds belonging to 56 genera, 32 families and 13 orders were recorded from Nijhum Dwip National Park. The eight major anthropogenic activities (overfishing, tourism, hunting, deforestation, sound pollution, settlement, agricultural practices, and water pollution) were observed in the study area throughout the study period. Of all the human activities, overfishing caused a severe level (27.88%) of disturbance followed by tourism (21.15%), hunting (18.26%), and sound pollution (14.42%) having a moderate level of disturbance. This study reveals that human disturbances have a severe impact on the habitat, food, breeding behaviour, and survival of birds. The obtained results are significant for the conservation and management efforts since they indicate levels of human disturbances across the habitat. By understanding the threats posed by human activities, we can preserve the habitat of birds and maintain the integrity of the ecosystem which contributes to the broader goals of biodiversity conservation and sustainable development in the region.

Key words: Bird survey, overfishing, tourism, hunting, sound pollution, disturbances and NDNP.

INTRODUCTION

Mangroves are the dominant ecosystems found along the coasts of subtropical and tropical regions worldwide which act as natural buffers between the land and sea (Wolf 2012). Mangrove swamps protect coastal areas from erosion, storm surges (especially during tropical cyclones), and tsunamis (Takagi

**Author for correspondence:* <tanzina@nstu.edu.bd>
 DOI: https://doi.org/10.3329/bjz.v53i1.82614

et al. 2016). These ecosystems are characterized by a unique assemblage of plants and animals that are adapted to the challenging conditions of the intertidal zone and also holds a vital habitat for birds that nest in their dense canopy.

The avifaunal diversity of an area needs to be described in outlining the stage and quality of the environment (Rajia *et al.* 2015). Birds are often utilised as an indicator variable in biological and ecological monitoring (Lin *et al.* 2008; Rajia *et al.* 2015). Birds provide all four categories of ecological services: provisioning, regulating, cultural, and supporting (Whelan *et al.* 2008). Through the services offered by birds, they indirectly and directly benefit humans as bio-indicators, pollinators, seed dispersers, predators, scavengers, and ecosystem engineers (Sekercioglu 2006; Wenny *et al.* 2011). Birds form a very pivotal link towards maintaining a healthy environment (Jaman *et al.* 1999; Rajia *et al.* 2015).

Anthropogenic activity is an acronym used to describe a variety of human-caused disturbance events that can affect wildlife and might also result in a strong impact on the environment and natural resources (Beilin *et al.* 2018). Habitat degradation, fragmentation, agricultural intensification, pollution, deforestation, and invasion by exotic species are some of the human disturbances that negatively affect the ecosystem (Mazumder 2014; Scanes 2018). Several studies suggest that increased human activities generally reduce community populations by reducing suitable habitat, food, and breeding opportunities, thus leading to the local loss of wildlife species (Thompson and Jones 1999; Jackson *et al.* 2001; Fernandez-Juricic *et al.* 2004). Research on the disruptive impact of human activity which is particularly acute for bird populations has mounted in recent times as human influences on wild species seem to accelerate (Jackson *et al.* 2001; Francl and Schnell 2002).

Nijhum Dwip National Park is an island that is ecologically important for the migration of water birds. Bangladesh Government declared Nijhum Dwip as a National Park in 2001 and also a Marine Reserve in 2019 (EAAFP 2011). Despite the importance and potential of wildlife diversity, very few research works have been conducted on anthropogenic activities in that area. Iftekhar & Takama (2008) conducted a study on perceptions of biodiversity, environmental services, and conservation of planted mangroves in Nijhum Dwip Island; whereas, Chowdhury *et al.* (2020) worked on globally threatened shorebirds of Nijhum Dwip National Park and management implications. Sobnam & Mamun (2021) studied land cover and coastline change assessment of Nijhum Dwip. Yet, detailed research with regard to anthropogenic activities relating to the avifauna of Nijhum Dwip National Park has not been done so far. The main objectives of

the current study were to make a checklist of the avifauna; to identify and quantify different sorts of anthropogenic activities; to analyze the impacts of anthropogenic activities; and to propose conservation measures to mitigate the effect of anthropogenic activities on avian diversity in the Nijhum Dwip National Park.

MATERIAL AND METHODS

Study Area: The Nijhum Dwip National Park (NDNP) is situated 3 km southwest of the Hatiya upazila and 115.3 km south of the city of Noakhali (Hossain *et al.* 2013; Chowdhury *et al.* 2020). It lies approximately between latitude 22°01''01" to 22°05'02" N and longitude 90°57'03" to 91°03'00" E (Chowdhury *et al.* 2020). The NDNP covers approximately 16,352 ha of area (Hossain *et al.* 2013; Chowdhury *et al.* 2020). Approximately 68% of the land is covered by mangrove forest making it a significant land use (Iftekhar & Takama 2008).

The NDNP has a generally flat topography, with the mean elevation at roughly 2.4 meters above the mean sea level (Rafikul *et al.* 2021). It has a tropical monsoon climate with heavy rainfall and a brief dry season (Rafikul *et al.* 2021). The monthly temperature varied during the study period and was recorded as lowest (14.93°C) in January and highest (32.92°C) in October. The current study was carried out at two different sites within the NDNP (Fig. 1). Those were -

Site A: Forest office and its surrounding areas: The Forest office is located on the southwest side of the NDNP. It has abundant natural resources spread across an area of 3600 ha. There are various mangrove forest tree species found in this area, such as Keora (*Sonneratia apetala)*, Gewa (*Excoecaria agallocha)*, and Baen (*Avicennia officinalis)* etc (Saha *et al.* 2014; Razia *et al.* 2019).

Site B: Chowdhury Canal Shore and its surrounding areas: Chowdhury Canal is situated in the western part of NDNP covering an area of 2100 ha. It constitutes different kinds of wetland habitats, including intertidal mudflats, brackish marshes, planted mangroves, sandbars, beaches, agricultural areas etc. (Bird *et al.* 2010; Kumar & Ghosh 2012). The region experiences twice-daily tidal inundations and is constantly changing, with frequent occurrences of sedimentation and soil deposition (Hossain *et al.* 2017; Sarker *et al.* 2021). Keora (*Sonneratia apetala*) is the most significant tree species planted here (Saha *et al.* 2014). This area plays a vital role in the winter migration of birds.

Study methods: The present study was conducted from October 2023 to March 2024. Fieldwork was conducted two times a day, in the morning (06:00-10:00) and afternoon (15:00-18:30) using the direct field observation method. Every month two days were dedicated to observe the birds and anthropogenic activities in each study site. The visibility of avifauna and the occurrence of

anthropogenic activities were taken into consideration while choosing the timing of the fieldwork. Binoculars (Bushnell 10X42) were used to observe the avifauna in the study area. The camera (Nikon D80 SLR) was to take photographs and record videos of the birds. To identify the avian species we followed Grimmett *et al.* (2021) and Ali (2002).

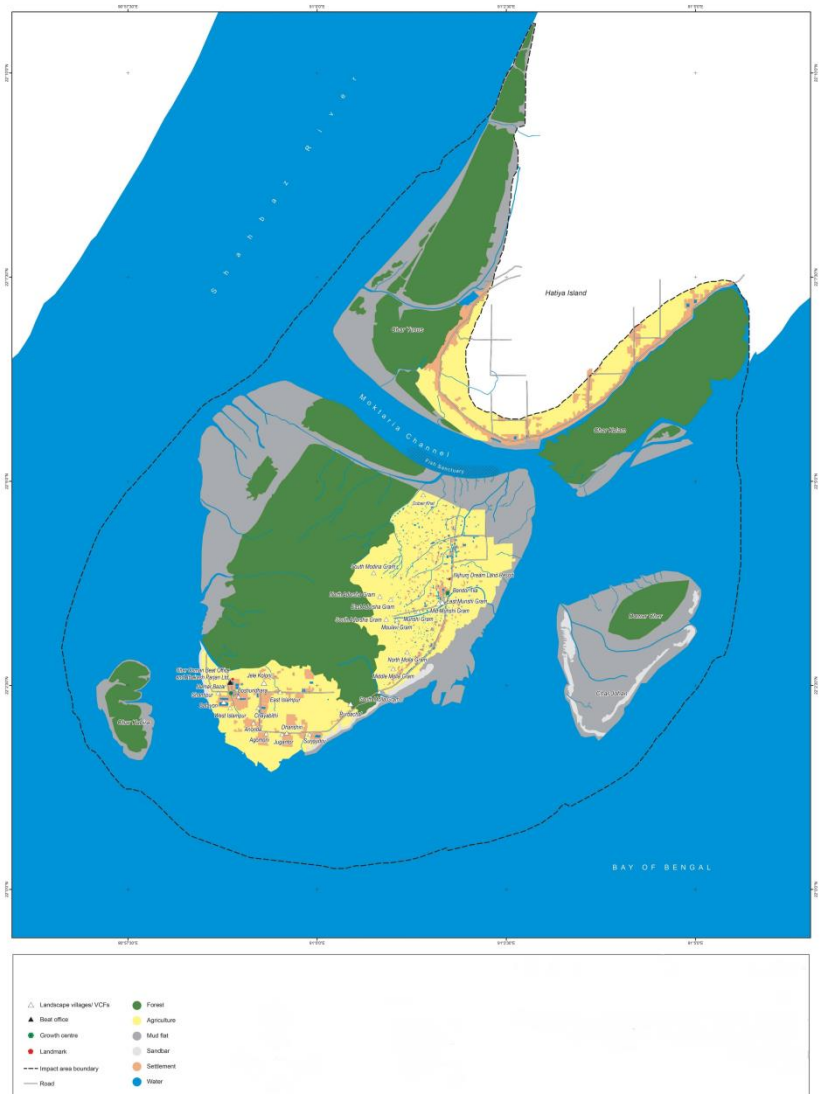

Figure 1. Map of the Nijhum Dwip National Park (CREL Project 2017).

Bird survey: The line transect technique was employed to survey birds in the study sites. There were a total of 40 transect lines. Each transect line was measured to be between 200 meters in length and 50 meters in width on either

side. Birds were counted inside the transect lines that were set out at the study sites. The bird population was estimated using direct counting (physical count and calls or voices). The study sites were routinely inspected by methodically walking on predetermined routes.

Analysis of anthropogenic activities: Every time the field was visited the frequency (n) of a particular event observed was recorded, leading to the occurrence frequency. To estimate, compare and quantify the exposure of human disturbances in a transect line, the total disturbances were summed together. Thus, the percentages of the disturbances in the two study sites were analyzed. To evaluate the level of disturbances a categorization system was developed based on their occurrence frequencies (severe level ≥ 25%, moderate level = 11%- 24%, and low level ≤ 10%).

Data analysis: The percentages of anthropogenic activities were calculated and obtained results were compared using the t-test. Microsoft Excel 2010 software was used for the t-test. The findings was considered significant if the value of $p<0.05$.

RESULTS AND DISCUSSION

Bird survey: During the bird survey, a total of 67 species were identified, comprising 13 orders and 32 families (Table 1). The total number of individuals observed was 1337. Among the orders, Passeriformes had the highest number 21 species (31.35%) of birds followed by Charadriformes 14 species (20.89%), Anseriformes 8 species (11.94%), Pelecaniformes 6 species (8.95%), Coraciiformes 5 species (7.46%), Falconiformes 3 species (4.47%), Piciformes 3 species (4.47%), Columbiformes 2 species (2.98%), and rest all orders 1 species (1.49%) each (Fig. 2).

The current bird survey showed that the number of avian species increased compared to the previous surveys. But the population sizes have decreased. Chowdhury *et al.* (2020) listed a total of 58 waterbird species and 12,898 individuals from the NDNP in 2020. The apparent reason behind the reduction of the bird populations might be the human encroachment in the national park area and the disturbances caused by them.

Table 1. Recorded bird species from the NDNP

Family	Scientific Name	Common Name	No. of individuals
	Order 1. Pelecaniformes		
Ardeidae	*Ardeola grayii*	Indian Pond Heron	11
	Bubulcus libis	Cattle Egret	44
	Ardea alba	Great White Egret	6
	Ardea cinerea	Grey Heron	1
	Ardea intermedia	Intermediate Egret	55

Threskiornithidae	*Threskiornis melanocephalus*	Black-headed Ibis	22
	Order 2. Anseriformes		
Anatidae	*Mareca peneloe*	Eurasian Wigeon	245
	Anus acuta	Northern Pintail	16
	Spatula clypeata	Northern Shoveler	23
	Tadorna tadorna	Common Shelduck	98
	Dendrocygna bicolor	Fulvous Whistling Duck	54
	Tadorna ferruginea	Ruddy Shelduck	7
	Dendrocygna javanica	Lesser Whistling Duck	112
	Anser indicus	Bar-headed Goose	26
	Order 3.Falconiformes		
Falconidae	*Felco Subbuteo*	Eurasian Hobby	3
	Haliastur indus	Brahming Kite	2
	Falco peregrinus	Peregrine falcon	6
	Order 4. Charadriiformes		
Laridae	*Sterna hirundo*	Common Tern	43
	Chlidonias hybrid	Whiskered Tern	122
	Gelochelidon nilotica	Common Gull-billed Tern	72
	Larus ichthyaetus	Pallas's Gull	82
Charadriidae	*Pluvialis squatarol*	Grey Plover	5
	Charadrius mongolus	Siberian Sand Plover	7
	Pluvialis fulva	Pacific Golden Plover	47
	Charadrius alexandrinus	Kentish Plover	16
Scolpacidae	*Numenius arquata*	Eurasian Curlew	2
	Actitis hypoleucos	Common Sandpiper	10
	Tringa glareola	Wood Sandpiper	4
	Numenius phaeopus	Whimbrel	4
	Xenus cinereus	Terek Sandpiper	16
	Tringa totanus	Common Redshank	20
	Order 5. Suliformes		
Phalacrocoracidae	*Microcarbo niger*	Little Cormorant	12
	Order 6. Cuculiformes		
Cuculidae	*Eudynamys scolopaceus*	Western Koel	1
	Order 7. Columbiformes		
Columbidae	*Columba livia*	Rock Dove	7
	Spilopelia chinensis	Eastern Spotted Dove	1
	Order 8. Piciformes		
Picidae	*Dendrocopos macei*	Fulvous-breasted Woodpecker	1
	Picoides canicapillus	Grey-capped Woodpecker	2
	Dinopium benghalense	Black-rumped Flameback	2
	Order 9. Strigiformes		
Tytonidae	*Tyto alba*	Common Barn Owl	1
	Order 10. Coraciiformes		
Meropidae	*Merops orientalis*	Asian Green Bee -eater	4
	Merops philippinus	Blue-tailed Bee-eater	2
Alcedinidae	*Alcedo atthis*	Common Kingfisher	1
	Halcyon smyrnensis	White-throated Kingfisher	1
	Todiramphus chloris	Collared Kingfisher	6
	Order 11. Caprimulgiformes		
Caprimulgidae	*Caprimulgus macrurus*	Large–tailed Nightjar	1
	Order 12. Apodiformes		
Apodidae	*Cypsiurus balasiensis*	Asian Palm Swift	6
	Order 13. Passeriformes		

Sturnidae	*Lamprotornis bicolor*	African Pied Starling	13
	Acridotheres fuscus	Jungle Myna	5
	Acridotheres tristis	Common Myna	3
Corvidae	*Corvus splendens*	House Crow	7
	Corvus macrorhynchos	Large-billed Crow	5
Dicruridae	*Dicrurus macrocercus*	Black Drongo	6
Oriolidae	*Oriolus larvatus*	Eastern Black-headed Oriole	1
Artamidae	*Artamus fuscus*	Ashy Woodswallow	13
Campephagidae	*Coracina macei*	Indian Cuckooshrike	2
Phylloscopidae	*Phylloscopus fuscatus*	Dusky Warbler	3
Rhipiduridae	*Rhipidura albicollis*	White Throated Fantail	1
Muscicapidae	*Ficedula albicilla*	Red - throated Flycatcher	1
	Copsychus saularis	Oriental Magpie Robin	5
Laniidae	*Lanius schach*	Long-tailed Shrike	6
Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	12
Paridae	*Parus major*	Great Tit	1
Hirundinidae	*Hirundo rustica*	Barn Swallow	7
Passeridae	*Passer domesticus*	House Sparrow	8
Polceidae	*Ploceus philippinus*	Baya Weaver	3
Motacillidae	*Motacilla cinerea*	Grey Wagtail	4
	Motacilla alba	White Wagtail	2
			Total= 1337

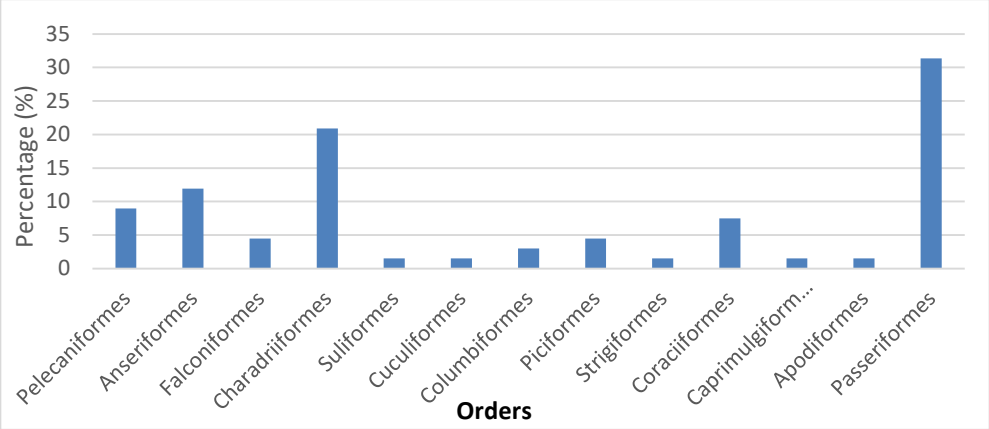

Figure 2. Percentages of occurrences of birds under different orders observed in the NDNP.

Analysis of anthropogenic activities

Anthropogenic activities in different study sites: A six-month assessment in the NDNP revealed that a total of 53% of human disturbances occurred in site-A. Among these disturbances, overfishing 27.27%, tourism 21.82%, hunting 16.36%, sound pollution 14.55%, deforestation 7.27%, settlement 7.28%, water pollution 5.45%, and agricultural activities 0% were recorded (Table 2). It had been found that a total of 47% of the anthropogenic activities took place in site-

B. The percentages were as follows: overfishing 28.58%, hunting 20.41%, tourism 20.40%, sound pollution 14.28%, deforestation 10.21%, agricultural activities 6.13%, water pollution 0%, and settlement 0% (Table 2).

The comparison of these two study sites revealed that the human disturbances in site- A is slightly higher than site- B and the disturbances in two study sites did not vary significantly (t= 0.999799). Among all the activities overfishing mostly affected both study sites. Hunting, tourism and sound pollution also moderately impact the ecosystem of these two study sites. Other activities have a minor impact on the ecosystem. Chowdhury *et al.* (2020) reported the mortality of shorebirds due to the use of fishing nets in the NDNP. On the other hand, Islam & Bhuiyan (2015) mentioned the occurrence of human activities including illegal logging and timber harvesting, pollution from shipping, oil spoilage, and other things in the Sundarbans mangrove forest.

Anthropogenic activities in different months: The current study findings reveal that anthropogenic activities in November (22.11%) were the highest, followed by October (17.30%), December (18.26%), January (19.23%), February (12.50%), and the lowest in March (10.57%) (Fig. 3).

The monthly differences in anthropogenic activities during the study period could be attributed to factors like seasonal fluctuations, tourism patterns, and fishing restrictions. Fishing activity peaks in November as local anglers take advantage of calmer seas and abundant fish after the rainy season. Besides, November marks the beginning of the dry season which is the peak time for the arrival of migratory birds. The mangrove forest and bird populations attract many tourists. These increased numbers of visitors are the reason for anthropogenic activities like fishing, hunting, pollution, and other disturbances. On the other hand, March marks the end of the winter season and the transition to pre-monsoon conditions. This period can bring heat waves, increased humidity, and unpredictable weather which potentially discourage tourism. Moreover, March aligns with the spawning season of fishes. Because of fishing restrictions, there may be a decline in fishing activity in March.

Levels of anthropogenic activities: During the study period, overfishing (27.88%) caused a severe level of disturbances among all anthropogenic activities observed in the NDNP. Subsequently, tourism (21.15%), hunting (18.26%), and sound pollution (14.42%) can be regarded as moderate level disturbances, with possible effects on bird species. Ultimately, deforestation (8.65%), settlements (3.85%) agricultural practices and water pollution (2.88%) can be considered as low level disturbances that may have accidental effects on bird species of the NDNP (Fig. 4).

Overfishing was the most significant human activity harming bird species. It directly affected the availability of food supplies for birds. Fish is a major source of food for birds living there. Therefore, when fish populations fall as a result of

overfishing, it disrupts the food chain. Thus, birds struggle to obtain enough food to survive and this may result in reductions in the bird population. Additionally, some birds were seen to get entangled with the fishing net which caused their death. Similarly, Chowdhury *et al.* (2020) reported that migratory birds in the park may be disturbed by local fishing operations and tourist activities in NDNP.

Table 2: Frequency of the anthropogenic activities in two distinct sites of the NDNP

Anthropogenic activities	**Name of the study sites**			
	Site A: Forest office and its surrounding areas		Site B: Chowdhury canal shore and its surrounding areas	
	Frequency of occurrence (n)	(%)	Frequency of occurrence (n)	(%)
Hunting	9	16.36%	10	20.41%
Overfishing	15	27.27%	14	28.58%
Deforestation	4	7.27%	5	10.21%
Sound pollution	8	14.55%	7	14.28%
Tourism	12	21.82%	10	20.40%
Agricultural activities	0	0%	3	6.13%
Water pollution	3	5.45%	0	0%
Settlement	4	7.28%	0	0%
Total	55	53%	49	47%

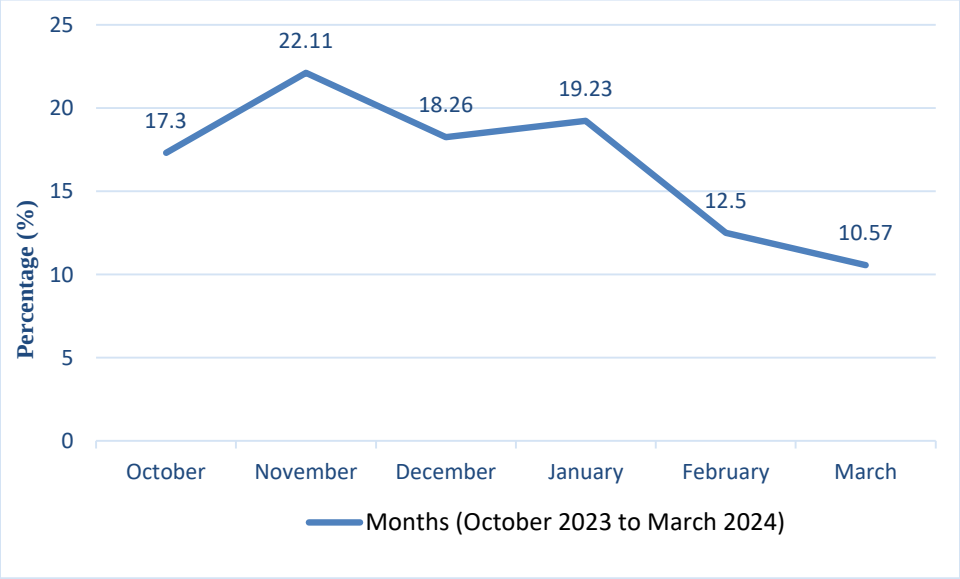

Figure 3. Anthropogenic activities in different months throughout the study period.

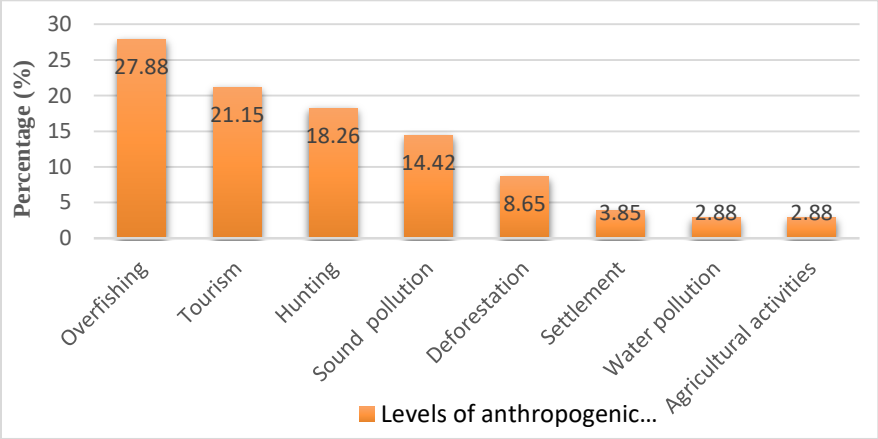

Figure 4. Levels of anthropogenic activities occurred in the NDNP.

Compared to overfishing tourism, hunting and noise pollution can be described as having average scores of disturbances, as these may result in more subtle or delayed changes to birds. The rest of the disturbances like deforestation, human settlement, water pollution, and agricultural activities may be less immediate in the study area. Chowdhury *et al.* (2020) stated hunting, habitat modification by humans, and livestock disturbance as minor hazards in NDNP.

Consequences of anthropogenic activities: Our observation reported that the major anthropogenic activities prevailing in the NDNP were mainly overfishing, tourism, hunting, and sound pollution. These activities have far-reaching consequences that negatively impact the habitat, activity patterns and behaviour of birds in the study area. These activities contribute to food scarcity, reduction of nesting sites and breeding grounds for birds, deterioration of the habitat, erratic nesting behaviour, and increased vulnerability to predation. In addition, the changes in the ecosystem affect the migratory bird species at both levels of habitat loss and migration rhythm. The current research revealed a reduced number of migratory birds compared to the study of Chowdhury *et al.* (2020). Therefore, these human disturbances affect not only the population of the birds but even the ecological dynamics that put the general health of the ecosystem at risk.

Many authors have reported human disturbance as a cause of concern for different species (Baudians and Lloyd 2007; Holm and Laursen 2009). Activities such as fishing and poaching directly exploit wildlife populations, leading to declines and even extinctions of species (Ripple *et al.* 2014). Steven & Castley (2013) identified tourism as a threat to critically endangered and endangered bird species.

Management implications: The management of anthropogenic activities at NDNP can be accomplished by a variety of strategies, such as community involvement, law enforcement, ecotourism development, and habitat restoration. In addition to offering sustainable subsistence options for the local population, these initiatives aim to reduce the adverse effects of human disturbances on biodiversity. Activities that are destructive to the park's ecosystem will be less common when it is supported by community-based conservation initiatives. The natural resources of the national park must be protected by strict monitoring of laws against illegal fishing, tourism, hunting and deforestation. For the management of anthropogenic activities cooperation among local people, NGOs, and government authorities is essential. The results of this research will assist the stakeholders in determining appropriate actions for management planning. Proper implementation, regulation, and public awareness are essential for conserving avifauna and maintaining ecological balance.

Several studies in recent years have reported that laws and regulations enforcement (Mascia *et al.* 2003), and research and monitoring bird populations (Newton 2004) help to mitigate anthropogenic activities.

CONCLUSION

The present study in the Nijhum Dwip National Park concludes by highlighting the significant effects of anthropogenic activities on avian populations and their habitat. The research findings indicate that overfishing, tourism, hunting, and sound pollution may have a disruptive impact on the activities, behaviours and population of the birds. These results consequently highlight the necessity of proper conservation strategies to reduce human disturbances and protect the national park. Further research is needed to gain a better understanding of the relationship between human activities and bird communities, ultimately aiding in the long-term conservation of this unique environment.

LITERATURE CITED

ALI, S. 2002. The Book of Indian Birds, 13th ed.. Bombay Natural History Society, Oxford Univ. press, Mumbai, pp. 198-200.

BAUDIANS, T.B. and LLOYD, P. 2007. Habituation and Habit Changes can moderate the impacts of Human Disturbance on Shorebird Breeding Performance. *Animal Conservation,* **10**, 400-407.

BEILIN, M.V., GAZNIUK, L.N., KUZNETSOV, A.V., STRUCHAEV, M.V., MANOHIN, D.K. and CHISTYAKOVA, E.Y. 2018. Anthropogenic activity: risks and protection safety of human life. *Revista Publicando,* **5**, 598- 605.

BIRD, J.P., LEES, A.C., CHOWDHURY, S.U., MARTIN, R. and HAQUE, E.U. 2010. A survey of the Critically Endangered Spoon billed Sandpiper Eurynorhynchus pygmeus in Bangladesh and key future research and conservation recommendations. *Forktail,* **26**, 1–8 .

BIRDLIFE INTERNATIONAL, 2025. Handbook of the Birds of the World and BirdLife International digital checklist of the birds of the world. http://datazone.birdlife.org. Accessed on 20 March 2025.

CHOWDHURY, S.U., FOYSAL, M., SHAHADAT, O., PRINCE, N.U., MOHSANINS, S. and ISLAM, M.T. 2020. Globally threatened shorebirds of Nijhum Dwip National Park and management implications. *Wader Study*, **127**(3), 244–251.

CLIMATE-RESILIENT ECOSYSTEMS AND LIVELIHOODS (CREL) Project. 2017. Nijhum Dwip National Park Impact Area. USAID.

EAST ASIAN-AUSTRALASIAN FLYWAY PARTNERSHIP (EAAFP). 2011. Flyway Network Sites in Bangladesh. EAAFP, Incheon, Republic of Korea. Accessed 28 Sep 2020 at: https://www.eaaflyway.net/ bangladesh/

FERNANDEZ-JURICIC, E., VACA, R. and SCHROEDER, N. 2004. Spatial and temporal responses of forest birds to human approaches in a protected area and implications for two management strategies. *Biological Conservation*, **117**, 407-416.

FRANCL, K.E. and SCHNEL, G.D. 2002. Relationships of human disturbance, bird communities, and plant communities along the land - water interface of a large reservoir. *Environmental Monitoring and Assessment,* **73**(1), 67-93.

GRIMMETT, R., THOMPSON, P. and INSKIPP, T. 2021**.** Field Guide to the Birds of Bangladesh. Helm. 320 pp.

HOLM, T.E. and LAURSEN, K. 2009. Experimental Disturbances by Walkers affects Behavior and Territory Density of Nesting Black-tailed Godwit *Limosa limosa***.** *Ibis ISI,* **151**, 77-87.

HOSSAIN, M.S., RAHMAN, M.F., THOMPSON, S., NABI, M.R. and KIBRIA, M.M. 2013. Climate change resilience assessment using livelihood assets of coastal fishing community in Nijhum Dwip, Bangladesh. *Pertanika Journal of Science and Technology,* **21**, 397–422.

HOSSAIN, K.T., TANIM, I.A. and UDDIN, M. 2017. Change detection of forest cover: a case study Nijhum Dwip national park, Hatiya, Noakhali. *Jagannath University Journal of Life and Earth Sciences,***2**, 1-2.

IFTEKHAR, S. and TAKAMA, T. 2008. Perceptions of biodiversity, environmental services, and conservation of planted mangroves: A case study on Nijhum Dwip Island, Bangladesh. *Wetlands Ecology and Management,* **16**(2), 119-137. DOI: 10.1007/s11273-007-9060-8

ISLAM, S.M. and BHUIYAN, M.A.H. 2018. Sundarbans mangrove forest of Bangladesh causes of degradation and sustainable management options. *Environmental Sustainability*, **1**, 113- 131.

JAMAN, M.F., SARKER, S.U. and SARKER, N.J. 1999. Food habits and feeding behavior of black drongo, *Dicrurus macrocercus albirictus. Bangladesh Journal of Zoology*, **26**(2), 57 -66.

JACKSON, J.B.C., KIRBY, M.X., BERGER, W.H., BJORNDAL, K.A. and BOURQUE, B.J. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science,* **293**, 629-637.

KUMAR, L. and GHOSH, M.K. 2012. Land cover change detection of Hatiya Island, Bangladesh, using remote sensing techniques. *Journal of Applied Remote Sensing*, **6**, 063608.

LIN, Y.P., YEH, M.S., DENG, D.P. and WANG, Y.C. 2008. Geostatistical approaches and optimal additional sampling schemes for spatial patterns and future sampling of bird diversity. *Global Ecology and Biogeography*, **17**(2), 175–188.

MASCIA, M.B., BROSIUS, J.P., TRACY, A.D. and TUNNER, N.J. 2003. Conservation and the Social Sciences. *Conservation Biology,* **17**, 649-650.

MAZUMDER, M.K. 2014. Diversity, habitat preferences, and conservation of the primates of Southern Assam, India: The story of a primate paradise. *Journal of Asia-Pacific Biodiversity*, **7**, 347-354.

NEWTIN, I. 2004. The Recent Declines of Farmland Bird Populations in Britain: An Appraisal of Causal factors and Conservation Actions. *Ibis,* **146**, 579-600.

RAFIKUL, M., KHAN, M.N.I., KHAN, M.Z. and ROY, B. 2021. A three-decade old assessment of forest cover change in Nijhum dwip national park using remote sensing and GIS. *Environmental Challenges,* **4**, 100162.

RAJIA, S., ALAM, M.M., CHOWDHURY, G.W., AKASH, M. and ISLAM, M.A. 2015. Status and diversity of birds of Ramna Park, Dhaka, Bangladesh. *Bangladesh Journal of Zoology*, **43**(2), 291-301.

RAZIA, S., ISLAM, M.I., PRAMANIK, M.A.T. and RAHMAN, M.M. 2019. Mapping Mangrove forest change in Nijhum Dwip Island. *Journal of Environmental Science and Natural Resources*, **11** (2019), 217-225. 10.3329/jesnr.v11i1-2.43388

RIPPLE, W.J., ESTER, J.A., BESCHTA, R.L., WILMERRS, C.C., RITCHIE, E.G., HEBBLEWHITE, M. and WIRSINGAJ. 2014. Status and Ecological effects of the World's largest Carnivores. *Science,* **343**, 1241484.

SAHA, P.K., BADIUZZAMAN, M., UDDIN, M.N., HOSSAIN, M.N. and SHANTA, A.S. 2014. A study on the management strategies of protected area in Bangladesh for biodiversity Conservation on Nijhumdwip, Noakhali, Bangladesh. *International Journal of Innovative Research and Development,* **3**, 140- 148 .

SARKER, K.K., BRISTY, M.S., SULTANA, I., KHANDAKAR, N., ISLAM, S., BAKI, M.A. and DAS, D.K. 2021. Diversity and Conservation Status of fish in the Nijhumdwip national park, Bangladesh. *Journal of Fisheries.* **9**(2), 92206.

SCANES, C.G. 2018. Human activity and habitat loss: destruction, fragmentation, and degradation. *Animal Humane Society,* 451-482.

SEKERCIOGLU, C.H. 2006. Increasing awareness of avian ecological function. *Trends in Ecology and Evolution,* **21**(8), 464-471. DOI: 10.1016/j.tree.2006.05.007

SOBNAM, M. and MAMUN, A. 2021. Land Cover and Coastline Change Assessment of Nijhum Dwip, Bangladesh, using Geospatial Analysis. *Global Journal of Human-Social Science*: *Biogeography, Geo-Sciences, Environmental Science & Disaster Management,* **21**(2), 1-9. DOI: 10.34257/GJHSSBVOL21IS2PG63

STEVEN, R. and CASTLEY, G. 2013. Tourism as a threat to critically endangered and endangered birds: Global patterns and trends in conservation hotspots. *Biodivesity Conservation*, **22**(4). DOI: 10.1007/s10531-013-0470-z

TAKAGI, H., MIKAMI, T., FUJII, D., ESTEBAN, M. and KUROBE, S. 2016. Mangrove forest against dyke-break-induced tsunami on rapidly subsiding coasts. *Natural Hazards and Earth System Science, **16** (7), 1629–1638*. doi:10.5194/nhess-16-1629-2016

THOMPSON, K. and JONES, A. 1999. Human Population Density and Prediction of Local Plant Extinction in Britain. *Conservation Biology*, **13**(1), 185-189. https://doi.org/10.1046/j.1523-1739.1999.97353.x

WENNY, D.G., DEVAULT, T.L., JOHNSON, M.D., CAGAN, D.K., SEKERCIOGLU, C.H., TOMBACK, D. and WHELAN, C.J. 2011. The need to quantify ecosystem services provided by birds. *The Auk,* **128**, 1-14.19. https://doi.org/10.1525/auk.2011.10248

WHELAN, C.J., WENNY, D.G. and MARQUIS, R.J. 2008. Ecosystem Services Provided by Birds. *Annals of the New York Academy of Sciences*, **1134**, 25-60. DOI: 10.1196/annals.1439.003

WOLF, B.M. 2012. Ecosystem of the Mangroves. NRES 323 – International Resource Management. University of Wisconsin-Stevens Point. 25 pp.

(Manuscript received on 10 December 2024 revised on 25 April 2025)