Spatial prioritization of selected mining pitlakes from Eastern Coalfields region, India: A species distribution modelling approach

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Abstract
Pitlake conservation is still a naive idea in a developing country. Species distribution modelling approaches can prove to be a useful tool in protecting biodiversity. The current study considers the ecological health of pitlakes through models of three winter migratory waterfowl species, namely Anser indicus (bar-headed goose), Nettapus coromandelianus (cotton pygmy goose) and Netta rufina (red-crested pochard), providing practical information for conservation setups in and around selected pitlakes in Eastern India. The AUC ± SD (Standard deviation) values of MaxEnt models of target species, viz. A. indicus, N. coromandelianus, and N. rufina are 0.729 ± 0.026, 0.772 ± 0.012, and 0.732 ± 0.024, respectively. Thus through the evaluation of the respective models and ground truth verification criteria, three pitlakes have proven to hold excellent conditions for the survival of these winter migratory birds as compared to the 20 studied ones. Three zones were created in these three lakes based on their characteristics to support these species and their associates. A large chunk of the region falls under the proposed zone of conservation priority sites from each of the three pitlakes. The need of the hour is to fulfill the voids between researchers, policymakers, and Eastern Coalfield’s administration and work towards implementing the proposed idea.

KEYWORDS
conservation, pitlake, pitlake conservation, species distribution modelling

1 | INTRODUCTION

Over the years, with anthropogenic expansion and change in the bioclimatic structure of the world, many suitable habitats and species have reached a fringed state of loss. The war to preserve increasingly threatened species and habitats with limited availability of resources (Brooks et al., 2002; Pimm & Raven, 2000), biologists around the globe are trying to identify areas that need to have a high priority for conservation (Norman, 2003; Olson & Dinerstein, 1998; Stattersfield, Crosby, Long, & Wege, 2005). The aftermath of mining through open-pit operation develops vestigial mineshafts, piles of leftover rock and gravel overburdening it, and leaving behind a high degree of damage to the natural landscape structure. Biophysical, biogeochemical, and ecological attributes of

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mines depend on the materials being mined. The ruts coming out from mining of biochemically inert substances, including limestone and bentonite, give a reflection of geochemical happenings in their respective surroundings (Eary, 1999). The term “pitlakes” has most of the time been confused with “regular lakes,” which developed as a cause of filling water in a dint. “Mining pit lakes” are formed mainly due to the backfilling of these deep pits for few or many years together. Recorded studies of pitlakes indicate that they have matured continuously to become self-aided aquatic hydro-structures, for example, Westfield pit lake, Scotland (Younger Paul, 2005), Alberta Pit Lake, Canada (Sumer, Pitts, McCulloch, & Quan, 1995) and Sleeper pit lake, USA (Dowling, Atkin, Belae, & Alexander, 2004). These lakes have an immense value as resources for various purposes starting from fisheries to supporting wildlife habitat which is dependent mostly on their topography, location and water use Soni, Mishra, and Singh (2014). Wetlands throughout the world had to face tough situations to survive through the air of destruction. Since the inception of Ramsar convention, wetlands have seen the light of conservation, but mining pitlakes (a result of open-cast mining activity) have still been neglected. To date, Ramsar documents a total of 27 critical wetlands in India, and none of them is mining pitlakes (Ramsar Secretariat, 2019). The matter of concern, right now, is the non-inclusion of old and self-sustaining mining hydro-structures under the Indian government’s initiatives, namely National Programme for Conservation of Aquatic Eco-system (NPCA) (Ramteke et al., 2016). The Eastern Coalfields region (ECR), India, has been one of the neglected areas for conservation of wetlands. It consists of 62 documented mining pitlakes and over 100 similar ones (Gupta, 2018) spread across the length and breadth of the region. ECR covers a massive area of 1,530 km² covering Bankura, Birbhum, Burdwan, and Purulia districts of West Bengal along with Dhanbad district of Jharkhand (Palit et al., 2016; Palit, Kar, et al., 2016; Palit, Roychowdhury, et al., 2016). The socio-economic evaluation of only 38 documented lakes out of a total of 62 ones suggests the huge dependency of the local population on these lakes (Palit et al., 2016, Palit, Kar, et al., 2016, Palit, Roychowdhury, et al., 2016). However, not a single lake got prioritization for building up conservation strategies. The avifaunal biodiversity monitoring sector has witnessed significant findings. Gupta and Mukherjee reported a total of 51 avifaunal water species (Gupta & Mukherjee, 2019). Two new avian species have also been reported from their extensive study (Gupta & Mukherjee, 2019). Of the species recorded, 41 were resident species, eight winter migrants, and two summer migrants. The current study aims to focus on three recorded winter migratory avifaunal species, namely Anser indicus, Nettapus coromandelianus, and Netta rufina, by developing species distribution models to study the ecological health of the pitlakes. All the three birds use these pitlakes as a stopover site during their winter migration. These pitlakes with ample food resources and proper resting place serve as suitable habitat for these species (Palit, Kar, Mukherjee, Gupta, & Banerjee, 2012). These bird’s nests in and around the water bodies and its adjoining vegetation. They are also predominantly herbivorous. Pitlakes have become an essential component in their lifestyle (Cramp & Simmons, 1977; Gupta, 2018; Mukherjee, 1974; Prins & Van Wieren, 2004; Snow & Perrins, 1998).

Though the water quality of few lakes is poor (Mondal & Palit, 2019), the growth of land flora and soil-dwelling animals prove the lakes offer favorable living conditions to the avian visitors (Palit et al., 2012), which in turn indicates that lakes hold a massive range of biodiversity. Past studies on documenting vegetation (Gupta & Palit, 2013; Gupta & Palit, 2014a, 2014b; Palit et al., 2016; Palit & Gupta, 2012; Palit, Kar, et al., 2016; Palit, Roychowdhury, et al., 2016), piscifaula (Gupta & Palit, 2014a, 2014b) and macroinvertebrate (Gupta, 2013) communities suggest that present pitlake conditions are capable of supporting ecologically diverse conditions. Chalking of socio-economic developmental plans seems to benefit only the anthropogenic needs (Palit et al., 2016, Palit, Kar, et al., 2016, Palit, Roychowdhury, et al., 2016), but robust biodiversity conservation plans for the pitlakes are a need of the hour. Thus, associated species with the reported waterfowl diversity may also get affected by the on-going destruction through post-mining activities. The present work is based on three important objectives which include a selection of pitlakes for developing immediate conservation priority sites (CPS). First, assisting the stakeholders and non-governmental organizations in chalking a long-awaited plan of pitlake conservation management strategy to achieve the goals set under West Bengal Wetlands and Water Bodies Conservation Policy, 2012 (Government of West Bengal, 2012). Second, to derive funds or CSR grants from Eastern Coalfields Limited for safeguarding lakes through Corporate Social Responsibility Policy, 2014 (Ministry of Corporate Affairs, 2014) under Companies Act, 2013 and finally, establishing a stern foresight to help pitlakes register under the National Plan for Conservation of Aquatic Eco-systems (NPCA) (Government of India, 2013). Species distribution modelling approaches across the globe inspire the current work (Brotos, MaNosa, & Estrada, 2004; Heinrichs, Bender, Gummer, & Schumaker, 2010). This investigation is also a pioneering study for the region intending to expand the conservation goals of pitlakes for the entire world.
2  |  METHODS

2.1  |  Area of investigation

We studied 20 pitlakes (Supplementary Material 1) out of the 62 documented ones for prioritization and immediate conservation. A total of 10 areas were surveyed, which fell under the Eastern Coalfields region, namely Jhanjra, Pandabeswar, Kenda, Kunustoria, Kajora, Kenda, Sripur, Satgram, Salanpur, Sodepur, and Mugma (Figure 1). The climate of the area was warm. The region experiences an annual temperature of 25.7°C and precipitation of about 995 mm annually (Gelaro et al., 2017). The investigation was carried out monthly under all the seasons and environmental conditions. A sandy-loamy soil composition has been seen in the studied areas (Palit et al., 2012), supporting a huge diversity of aquatic plants and waterfowl species (Gupta, 2018; Palit & Gupta, 2012). Area of the lakes ranged from 2 to 18 ha with a mean value of 8.3 ha. The altitude was 78–147 m msl in the command area of Eastern Coalfields Limited (ECL). For documenting the avian diversity, extensive field visits were conducted during March 2017–March 2019. Prior to the field visits, the sampling area was divided into grids of 100 m². QGIS version 3.6.0 (QGIS Development Team, 2019) enabled the creation of grids by overlaying them over the satellite imagery of studied pitlakes. The average survey route length was approximately 120 km, generally taking an average of 2 hours (excluding sampling time) to complete under ideal conditions. The checklist method helped in documenting waterfowl species from the area. A separate database was maintained for birds flying over the pitlake habitat. Observations were made between sunrise and midday daily during the investigation tenure using an Olympus binocular (8X21 RCII). Species were photographed using NIKON D3500.

2.2  |  Selection of target species to assess the health of pitlakes

We have selected particular winter migratory waterfowl species, namely Anser indicus (bar-headed goose), N. coromandelianus (cotton pygmy goose), and N. rufina

FIGURE 1  Map of the study area depicting all the studied 20 lakes
(red-crested pochard). White, grayish ashy and brown body, a shiny white head with two black bars, one shorter under the nape, and one across from eye helps in the identification of bar-headed geese generally. The white stripes on both sides of brown neck; ashy colored breast; yellow bill along with blackish tip; faded ashy upper plumage, every feather has a white tinged edge; clear brownish flanks with dark scapulars; complete gray tail and bright yellow legs; males and females look almost alike (Kumar, Sati, Tak, & Alfred, 2005a, 2005b, 2005c). It is omnivorous but predominantly feeds on seeds of grasses, leaves, roots, tubers, grains, and nuts (Akbar, Khan, Mehboob, & Nisa, 2005). It also resorts to eating small fishes and aquatic macroinvertebrates when it does not find seeds of grasses (Weigmann & Lamprecht, 1991). They are said to provide great ecotourism value to the refueling stops during their migrations and diligently helps in the dispersal of many grass species seeds in the locality (Bhattacharyya, Sen, Roy, & Mazumdar, 2008; Prins & Van Wieren, 2004). Besides, they can also be carriers of the H5N1 virus and are capable of spreading the virus to humans as well as animals (Cui et al., 2011).

Cotton pygmy goose shows dimorphic characters; a black and white color body characterizes the male with a distinct collar of black around the lower side of neck, blackish head and neck with intermittent whitish patches, the crown is mainly glossy green. The presence of a black bill; iris has a distinct shade of crimson-red; a dark greenish glossy faintly mixed with purple, conspicuous white wing-bar seen during flights; white inner parts; legs black; dark brown tail while female-only differentiates with their dull regularized-brown; across the eyes, a dark line passes through and inconspicuous wing-bar of white color; retaining other characters of males (Kumar et al., 2005a, 2005b, 2005c). This species dwells for food mainly at the surface of the water. They predominantly feed on small fishes, crustaceans, insect larvae mollusks, as well as plant parts from species such as Ipomoea and Hydrilla (Mukherjee, 1974). They fly briskly, often low over the water, and are very quick to escape falcons. The courtship phenomenon in them is still mostly undocumented. However, a distinct post-copulatory action present with them showcases male arching its neck displays its white neck feathers along with the white wing patches (Johnsgard, 1978).

Males of red-crested pochard shows a fairly golden-orangeish with a crest of silky chestnut tinge; blackish-brown neck, an upper side of tail and rump; the bill has a shade of bright crimson red; white band present at wing bases; silvery-grayish and brownish tail; fleshy tinged legs while the female has a haggard grayish-brown head; red-tipped black bill, wings similar to male but a bit more sallow and pale, gray replaces white wing. Male are more or less similar to the female, but its underparts are brown, the bushy appearance of the crest; the glazy luster of bill, eyes, and feet detained (Kumar et al., 2005a, 2005b, 2005c). Red-crested pochards are herbivorous. They feed on aquatic plants, macrophytes, and charophytes during their breeding season (Cramp & Simmons, 1977; Snow & Perrins, 1998). In their non-breeding season, they seem to dwell on sedges, tape-grasses, and rice, which are helpful for them to develop a winter seed diet (Allouche, Roux, & Tamisier, 1988). Besides, the activity of feeding on fungus is present in them (Llorente, Ruiz, & Serra-Cobo, 1986). They help in controlling wetland plant populations, improve ecotourism of the area, and also act as a seed disperser (Lewin, 2014). All three birds are winter migratory birds in the region (Ali, 2002).

2.3 Distribution data and environmental variables

The spatial distribution data for each bird from the Global Biodiversity Information Facility database (GBIF, 2019a, 2019b, 2019c) and supplementation of the same with field surveys enabled us to make robust distributional models. A total of 2,884, 3,642, and 1,050 georeferenced points were taken for A. indicus, N. coromandelianus, and N. rufina, respectively during 2017 to 2019. The close distances between each sampling point may develop spatial autocorrelation, which in turn negatively hampers the accuracy of the model. The spThin package of R software (Aiello-Lammens, Boria, Radosavljevic, Vilela, & Anderson, 2015) enabled to randomly remove a point with distances of 10 km between two points of the three species as the range of these species are restricted for some time in the vast pitlake locality, thus helping in building robust models for migratory birds. (Milchev, 2009; Zhang et al., 2019). A series of 324, 483, and 229 occurrences were obtained for A. indicus, N. coromandelianus, and N. rufina, respectively after spatially thinning each dataset.

The current climatic variables obtained from the WorldClim database, version 2.0 (Fick & Hijmans, 2017), enabled the clarity in understanding distribution models of target species. Geographical resolution of 30 arc sec (approximately 1 km² resolution at the equator) for all 19 environmental climvariables ensured the building of better models. Along with climatic variables, we selected a non-climatic variable (i.e., altitude) to improve the augmenting efficacy of species distributional models (Hof, Jansson, & Nilsson, 2012). A thorough inspection of possible correlations between all climvariables has displayed an excessive associativeness with the lower functioning
of models (Dormann et al., 2013). Therefore, the applicability of Pearson’s correlation coefficient for each pairwise evaluation of all 19 environmental climvariables and one non-climatic variable helped to point out as well as isolate excessively correlated ones \((r > 0.75)\). The selected climvariables for each studied waterbird species have been described with their contribution towards building the models (Supplementary Material 2).

### 2.4 Building the models with appropriate MaxEnt settings

MaxEnt was used to build the individual models (Dudík et al., 2007). Presumably, algorithms of eight MaxEnt models were conducted using the biomod2 package of R software (Thuiller, Georges, Engler, & Breiner, 2016) to chalk out the best-fit for datasets by appraising model faultlessness based on the area under curve (AUC) of the receiver operating characteristic (ROC) (Fielding & Bell, 1997). The accuracy of MaxEnt provides us with the highest AUC values, which led us to only display and use MaxEnt models for mapping. The spatially thinned data for each species were used in their respective models to showcase their special distributional status in the country. The non-correlated environmental climvariables for presence-only data were used as environmental raster layers for each model. Nonetheless, separate models were developed for each waterfowl species considering their immense conservational importance in the area. Each dataset was divided into 70\% for training and 30\% for testing to evaluate the precision of models due to unavailability of independent data, and then 10 replicates were carried out for each algorithm with the replicate type being set to subsample (Coxen, Frey, Carleton, & Collins, 2017; Zeng et al., 2015). We used the average suitability model of each algorithm for further analyses. For each species distribution model, we used 10,000 random pseudo-absences for their better evaluation (Giné & Faria, 2018). All these models were made to follow an L-1 regularization procedure to avoid over fitting error present in them (Franklin, 2005). This simplicity in procedure ensures us to biologically interpret our models in a better way (Merow et al., 2014). Distributional models were adjudged poor when AUC value is <0.5 per contra 1 implies impeccable performance. Generally, AUC values in the range of 0.7–0.8 quintessentially imply good model performance (Pearson et al., 2006). Eventually, evaluation of climate variable importance was assessed by comparing changes in AUC value (\(\Delta\)AUC) with as well as without a specific environmental factor, but with all other variables included. The jackknife test helped to evaluate the individual contributions made by each of the selected environmental variables in the development of the respective distributional model.

### 2.5 Planning for selecting conservation priority sites (CPS)

Three lakes were selected based on the presence of target species with a good facility of a large patch of the forest; suitability of water; density of trees; aquatic as well as terrestrial plants diversity across hammock area and adjoining areas. Satellite imagery of selected pitlakes was obtained using Google Earth (Google Earth, 2019a, 2019b, 2019c), and the division of each grid into 100 m\(^2\) was lined down by considering approx. 1\(^\circ\) = 111.32 km (Longitudestore, 2019) in QGIS 3.6 (QGIS Development Team, 2019). Suitable mining pitlakes were selected only after excessive ground truth verification. The red grids showcase the conservation priority sites (CPS). The yellow grids denote habitat development zones (HDZ), while the blue zonation represents likeliness of overlap between the first two grids with the human influence, which designates an area known as eco-overlap zones (EOZ). The ground truth verification was done manually across areas of selected lakes to check their habitat suitability by visiting each grid according to their georeferenced coordinates (Supplementary Material 3). Survey periods mentioned above were kept intense even to track down local bird species, their nesting habitat, and availability of food in the lakes to select each of the pitlake accordingly. Thus, to understand the quality of pitlakes for supporting biodiversity and chalking out CPS, we emphasized on a ground truth reality check, which was facilitated with grid mapping of area for convenience to policymakers.

### 3 RESULTS

#### 3.1 Model results

A clear-cut distinction was seen/notice where pitlakes fell under either fair or high suitability areas as predicted by distributional models. The model predicted distributional suitability based on habitat compatibility of each target species spread across the area. The complementary log-log or clog log statistical approach determines the habitat suitability range for the species, which gives an estimate of probable species presence (Elith et al., 2011; Phillips, 2017). The habitat suitability in Figure 2–4 represents distributional information about the species. Red
color depicts while blue color demarcates higher species concentration in an area (Gomez & Cassini, 2015; Kalle, Ramesh, Qureshi, & Sankar, 2013). The AUC ± SD (Standard deviation) values of MaxEnt models of target species, viz. *A. indicus*, *N. coromandelianus*, and *N. rufina* are 0.729 ± 0.026, 0.772 ± 0.012, and 0.732 ± 0.024, respectively. The result implies that model performance was good and suitable to predict the habitat suitability of studied target species (Pearson et al., 2006). Altitude is a constant driver constituting as a non-climatic variable in each of SDMs built. The AUC figures (Figure 5-7) for *A. indicus* shows that it is driven by bio_1, bio_2, bio_3, bio_4, bio_12, bio_14, and bio_19; Model of *N. coromandelianus* is guided by bio_1, bio_2, bio_3, bio_8, bio_9, bio_12, bio_14, bio_15, and bio_18; consecutively model of *N. rufina* is steered by bio_1, bio_2, bio_3, bio_4, bio_9, bio_12, bio_14 and bio_15. Bio_12, bio_9, and bio_3 made the highest contribution in terms of climatic variables for developing the SDMs for *A. indicus*, *N. coromandelianus*, and *N. rufina*, respectively.

### 3.2 Suitability prediction

The presence of good quality food, shelter places, and minimal human interferences in the area are criteria for ground-truthing of the environmental conditions. The ground-zero criteria included the abundant presence of suitable food for the migratory birds such as the presence of macroinvertebrates, fishes, tubers, seeds, fruits, and grasses like *Saccharum spontaneum*. It also stressed that the aquatic environment must be less polluted and should not affect the health of the birds. Based on these criteria, three zones, namely, CPS, HDZ, and EOZ surrounding the lakes enabled us to understand the ecological health of the lakes.

SDM built on *A. indicus* predicts pitlake number 1 to fall under a highly suitable category with effective ground-zero checks, mandates its selection for conservation purpose of this species. Similarly, SDM created on *N. coromandelianus* suggests all pitlakes fall under a fairly suitable block mandating to select anyone for conservation works. However, ground verification results...
stress on the fact that none of the pitlakes have a good area to hold potential biodiversity within its realm except pitlake numbered as nine, which can cater to the needs of this migratory bird. The model built on *N. rufina* predicts all studied pitlakes to fall under the very highly suitable category, ground-zero confirmation allowed us to select 16, and 1 tagged pitlakes to cater to the conservation of this species effectively. Models (Figure 2) and ground zero verification pinpoint three pitlakes numerically tagged as 1, 9, and 16 to have a great all-around facility for the survival of these winter migratory birds in this region.

### 3.3 Area under zones

The total average spatial area for proposing conservation priority sites is 1966 m² combined for selected three lakes; 866 and 966 m² are average spatial areas of HDZ and EOZ for the lakes. From the total area of all three zones, 60.4%, 42.8%, and 61.3% of areas fall under CPS for pitlake numbers 1, 9, and 16, respectively. It is important to note that a large percentage of the area comes under the proposed CPS category making it viable for better conservational priority. HDZ comprises 20.45%, 21.42% and 26.82%; EOZ maps out 18.18%, 39.28% and 24.39%; both zonation percentage are for pitlakes tagged as 1, 9, and 16, respectively (Figures 8-10).

### 4 DISCUSSION

#### 4.1 Idea behind zonation patterns

Conservation priority sites defined in the case of each pitlake consist of a huge diversity of plants, both aquatic and terrestrial. It also serves as a home for studied migrant species where their nests were observed during the tenure of investigation. Food habit for each bird species also suggests the presence of macroinvertebrate, macrophyte, phyto as well as zooplankton diversity in pitlakes. CPS regions have naturally been preserved without any human interference. Biodiversity remains intact in nook and corner of conservation priority sites. Results...
directly indicate that a huge percentage of pitlake vicinity areas fall under the CPS category, which means a natural restoration of the area has taken place quite well. Water quality and soil quality are excellent, which are enabling a rich growth of plant species both on aquatic and terrestrial habitats supporting avian and arthropodal richness. CPS categorized places need to be brought under immediate conservation for sustaining diversity for the future. HDZs are characterized by scanty vegetation of bushes, deciduous tree species, and grasses. Soil is covered with big chunks of excavated rocks, making it difficult for plant communities to succeed. Water accessible areas have been found in HDZ crops; anthropogenic interference is quite evident in this zone. Anthropogenic water needs are fulfilled through this zone. An interesting fact is documented residential bird species’ nests have been found within the vicinity of this zone, adding an extra biodiversity point to the zone. This sector can easily be paneled for indigenous tree planting and habitat development-oriented programs. Even in some areas of HDZ, small trails are present which showcase the use of pitlake water for various human chores. It effectively serves as a mutual connection between sustainable use of pitlakes and anthropogenic water supply. Talking about CPS and HDZ, they both showcase immense potential to hold and nurture diversified as well as a distinct group of migrant and local bird species in association with a distinct group of plant communities in both sectors. Eco-overlap zones have shown more or less contrasting characteristics as compared to the other two zones. This zone is characterized by road connections, agricultural lands, and human housing facilities. It has anthropogenically facilitated crop plantations and concrete structures. Coinciding with the other two zones at certain levels, EOZ intends to deliver a function similar to the buffer area in case of sanctuaries or wildlife parks. EOZ has shown maximum infiltration by bipedal beings. It has directly shown slow interference of humans creeping into designated CPS sectors for woods and hunting of bird species due to the non-availability of protection to pitlakes. EOZ should be able to contain humanistic activities to itself, and allow humans to access HDZ sectors for completion of its water needs.

FIGURE 4 The species distribution models for the three studied species *Netta rufina*
4.2 Google base maps and pitlakes

Over the years, Google Earth and Google Maps have been approved by many noted researchers and institutions for research purposes over other map providers around the globe. The specialty of Google maps is that even an amateur can understand and procure the necessary spatial data from the maps. In the current study area, it can play a vital role in locating these pitlakes by simply adding information regarding the lakes to the maps. This lucid strategy can be adopted by any human being with a phone. Google base maps helps to keep the content lucid for the public to understand it in an easier way. The mapping of migratory bird stoppages can also be recorded on Google maps by just adding information of the kinds of avian visitors in the description of the area, this enhances the quality and robustness of the area in a Google Map (Swatantran et al., 2012). The use of Google Maps ensures convenience and easiness for readers as well as policymakers; further usage of it should be limited to search, guide, and practical conservation purposes only (Nawale et al., 2015; Olea & Mateo-Tomás, 2013). It is vital, right now, that researchers and general public can come together and record these pitlakes independently. These activities have the potential to safe guard a pitlake or any area which is in dire need of conservation. This will bring a sustainable approach in using pitlakes and safe guard the pitlakes for future.

4.3 Current scenario

The presence of studied mining pitlakes under the fairly to very high suitable areas predict their capability to hold on to a biodiverse range of species within their range. The current aspect of studies throws light on the fact that the conservational approach can easily be made in these extensively surveyed regions. Concerning things about their conservation setups is the non-availability of funds and the presence of coal mafias. Eastern Coalfields Limited is a primary stakeholder of studied areas and adjoining areas (Eastern Coalfields Limited, 2012) and holds sole responsibility to allocate funds towards conservational and livelihood development schemes, which unfortunately is not being executed currently. The 43rd Annual Report of Eastern Coalfields Limited mentions that it has attained a large jump in net profit of 34.66%, which stands at 2108.802 billion USD for the fiscal year of 2017–2018 (Eastern Coalfields Limited, 2018a, 2018b). Under Companies Act 2013, section 135 (5) of Corporate Social Responsibility (CSR) policy clearly states that “the Board of every company referred to in subsection (1) shall ensure that the company spends, in every financial year, at least 2 %. of the average net profits of the company made during the three immediately preceding financial years” (Ministry of Corporate Affairs, 2014), which mandates ECL to pay 42.176 billion USD as CSR fund for the financial year 2017–2018.
towards promoting livelihood developmental or conservational activities. The official report claims that ECL has only utilized 0.126 billion USD under CSR spending for livelihood developmental activities (Eastern Coalfields Limited, 2018a, 2018b). A balance of 42.05 billion USD remains unused that can be effectively used in conservational or anthropological developmental activities. It points out towards non-usage of such a huge amount, which directly or indirectly is being misdirected into some other nuisance activities rather than benefiting the society or nature (Narayanan, 2015).
Simultaneous situations from around the globe

In Madagascar, SDMs built on various organisms such as plants, fishes, invertebrates, reptiles, amphibians, birds and mammals have been effectively used to define “potential sites for conservation” which led to the development of a legal decree that stopped all kinds of human activities in that region (Kremen et al., 2008). Similarly, in Australia SDMs built on 2,300 species of animals and plants were combined with other conservation works and timber values to recognize areas of high conservation value for exclusion from logging, thereby resulting in major additions to the regional network of protected areas which was hugely successful (Ferrier, Watson, Pearce, & Drielsma, 2002). In addition to the development of biodiversity laws for terrestrial ecosystems, SDMs built on Banff Springs snail have effectively contributed to the protection of five thermal springs in the state of Ottawa, Canada (Lepitzki, 2010; Lepitzki & Pacas, 2010). Unfortunately, SDMs have not yet been built on self-sustaining mining pitlakes because they still pose challenges throughout the world. The hindrances include, (a) no clear vision as to the ultimate use of these mining pitlakes, (b) exclusion of mainstream ecologists from pitlake biodiversity conservation planning and design which in turn increases the complexity of rehabilitation and restricting the provision of ecosystem services, and (c) pitlake ecology which includes both theory and application has not yet found a foothold in mainstream ecology, limiting scientific exposure to the issue of these lakes and holding back conservation planning of them (Blanchette & Lund, 2016). The promising example of Capel lakes from South-West Western Australia, which were developed after mining activities of mineral sands was completed, continued to grow better, and has now become a suitable habitat for many waterfowl species (McCullough & Lund, 2006). Thus, combining SDMs
with ecological and wildlife data thriving in and around the pitlakes from nook and corner of the globe can generate concrete reasons to conserve the biodiversity with some legal decree.

4.5 Addressing the lacunae between policymakers and scientists

An indigenous report suggests the proper implementation of mine restoration works are not carried out to its full extent in degenerated areas under ECL province (Dikshit, 2016). Even restored areas with considerable amount of biodiversity are not taken care of by the authorities. The office of ECL can easily distribute conservation workload to NGOs or educational institutes to carry out necessary works. It seems that there is a huge lacuna between policymakers, stakeholders, and research personnel working in the area. SDMs without any doubt can help the conservation scientists and policymakers to mandate decisions (Brown, Hines, Ferrier, & McKay, 2000; US Fish & Wildlife Service, 2007; CTFC, 2008; Cayuela et al., 2009; Leipitzki & Pacas, 2010; Environment Canada, 2011). The hidden potential value of environmental niche models can only be explained to managers and policymakers by bringing the greater amount of lucidity with an easy structure of discussion in nature camps and official meetings by the conservation scientists. Authorities can also be explained to facilitate the need to feed the results of existing SDMs applications back to scientists. This frame of reference considers conservation as a decision-forging fabric and facilitates an easy work exchange formula between these two groups. A decision process should be outlined that would include a comprehensive discussion of a problem, objectives, probable potential actions, negative–positive effects of the defined actions, assessing associated uncertainty and considering trade-offs among these consequences (Addison et al., 2013; Das, 2019; Gregory et al., 2012; Schwartz et al., 2012).

FIGURE 9  The zonation patterns of pitlake numerically tagged as 9 (Pathaldanga pitlake). All the grids are numbered for convenience and their coordinates have been included in Supplementary Material 3. The red colored grids delineate zones for conservation priority sites (CPS); yellow colored grids are meant to mark out areas of habitat development zones (HDZ); blue colored grids show the areas of eco- overlap zones (EOZ)
4.6 Conclusion

In the ECL area, Gunjan Ecological Park serves an inspirational initiative towards the protection of birds and plant species; it allows human interference to the extent of recreation through the concept of building a bridge between nature and human beings. It has been built around an old mining pitlake dating back to more than 50 years. Nevertheless, the ecological park concept implemented here does not safeguard any species, allowing human infiltration for recreation has adverse effects on thriving organisms. Another prominent example is of the Khadan Kali pitlake; safeguarding it has been done through the creation of sacred grove; not a single species is touched, which is present within the vicinity of it, allowing a sprawling green scenery with diverse bird species being present in the area. It remains unnoticed and undocumented in terms of its sociobiological importance. Both examples are serving as a foundation for setting up conservation priority regions. Other studied pitlakes can be used for the completion of water needs and pisciculture experiments, which can generate substantial livelihood to residents of the area. There exists many such areas other than mentioned studied regions that are overlooked by government officials and ECL area managers as they believe substantial wastage of money occurs when restoration or conservation priority regions are set up. The plight of each migratory bird and related phyto or arthropodal species are also believed to worsen if conservation regions were not set up in the studied areas; what comes as a surprise is that acres of land and pitlakes remain unexplored by scientists and field workers in the ECL regions. The proper implementation of setting up conservational regions in the studied areas must be given utmost priority. These mining pitlakes are a true home for sustaining a large group of organisms. The current study will pave a path to bring studied mining pitlakes under central and state government's schemes such as National Plan for Conservation of Aquatic Eco-systems (NPCA) (Government of India).
India, 2013), West Bengal Wetlands and Water Bodies Conservation Policy, 2012 (Government of West Bengal, 2012), by being India’s first mining pitlakes to be included under its shade. It also provides national as well as state policymakers to adopt this framework for setting up conservation regulations for existing self-sustaining mining pitlakes. Indirectly, ECL will be able to carry forward this framework and can implement conservation setups for their indigenously studied pitlakes through its CSR activities, enabling them to become the country’s first public sector company to have conservation implementation activity under CSR scheme. Current work can be adapted in other developing countries that have self-sustaining pitlakes to ensure safeguarding the organisms thriving within its vicinity.

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CONFLICT OF INTEREST
The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS
Snehangshu Das has contributed to field data collection, conception and design, analysis and interpretation of data, and drafting of the manuscript. Aparajita Mukherjee and Santanu Gupta have contributed to the conception and design, acquisition of field data, and manuscript revision.

DATA AVAILABILITY STATEMENT
All information are available online at https://github.com/snehangshudas/IndianPitlake.git (Pitlake Database for Eastern Coalfields, India).

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SUPPORTING INFORMATION
Additional supporting information may be found online in the Supporting Information section at the end of this article.

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