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# GIS Mapping and Distribution of Indian Peafowl (*Pavo cristatus*) in India by Using Citizen Science Data

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**Abstract:** The Indian peacock or Blue peafowl (*Pavo cristatus.*), the largest of the pheasants commonly called Mor or Mayur, is a bird species recognized for its beauty. *Pavo cristatus* (Indian peafowl) has been justifiably declared as the National Bird of India in 1963. In India, it is given the ultimate protection by its inclusion in the Schedule I of Wildlife (Protection) Act, 1972. The main objective is to encourage citizen participation in generating baseline information using sight records and enable long-term monitoring of Indian peafowl in India. The present study deals with the status and distribution of Indian peafowl in India and the data used is taken from the citizen science database of eBird. The complete dataset of Indian peafowl from 2001-2017 was used to prepare the distribution maps in different years as well as to obtain information on the species' location, and the number of a social group in India. Some potential reported sites were verified during 2013–2017 by visiting the distinct locations. From 2001 to 2017 we found 71,632 records from 15,151 contributors across 26 states/union territories of India. Percentage of individuals observed was 38% (in 2017), 27% (in 2016) and 16% (in 2015) whereas 0% was recorded in 2002, 2006 and 2007. The citizen science data obtained thus has the potential for increasing our understanding of current peafowl distribution patterns, and for categorizing important sites for conservation/protections and to perform occupancy and habitat modeling of Indian peafowl species in India.

Keywords: Species distribution, Indian peafowl, eBird, Citizen science, National bird

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#### Introduction

The Peacocks are omnivore medium-sized birds belonging to the family Phasianidae, order Galliformes (Johnsgard, 1986; Ali and Ripley, 1989). There are two main species of Peacocks-the Green Peacock and the Indian Blue Peacock which have a strain of white peafowl. The Indian Peacock or Blue Peafowl (*Pavo cristatus.*), the largest of the pheasants commonly called Mor or Mayur, is a bird species recognized for its beauty, especially the male, in particular for the long train made up of elongated upper-tail covert feathers with colorful eyespots. *Pavo cristatus* (Indian peafowl) has been justifiably declared as the National Bird of India in 1963 due to its 'flagship' value founded on its glorious position in mythology and its widespread distribution and grandeur. It occupies a prominent place in Indian art, culture and folklore due to its colorful plumage and attractive display.

The grey literature reveals the documentation of such bird by various scientists and authors such as Linnaeus (1758), Sclater (1860), Baker and Inglis (1930), Ambuel and Temple (1983), Johnsgard (1986), Ali and Ripley (1989), Robert (1991), Yasmin (1995), Silva *et al.* (1996), Grimmett *et al.* (1998), Gregory *et al.* (2004), Mushtaq *et al.* (2012), Chopra and Kumar (2012), Kakde (2012), Bhattacharya *et al.* (2013) and Venugopal *et al.* (2014) worked on this field.

Male Indian peafowl has characteristic colorful tail feathers or train. The feathers of the Blue Peafowl and both the Jungle fowl are also in demand. Illegal trade in live birds is also a problem to reckon with. The Indian Peafowl (*Pavo cristatus*) was once widely distributed and abundant throughout the Indian mainland except for the Himalayan ranges and North-East India. In recent years, there has been an increasing concern about their declining status.

The literature available regarding the Indian Peafowl is very poor. No recent study is available regarding the above topic. Data of peafowl about the Indian continent is very poor and some of the parts have been ignored in the concept of surveys and monitoring of threats. In this study we provide data on the above topic about the boundaries of India as to the best of our knowledge there exists no study on this aspect.

## **Materials and Methods**

India lies on the Indian Plate, the northern part of the Indo-Australian plate. On the south, India bounded by the Indian Ocean in particular, by the Arabian Sea on the west, the Lakshadweep Sea to the southwest, the Bay of Bengal on the east, and the Indian Ocean to the south. The northern frontiers of India are defined largely by the Himalayan Mountain range that touches the borders China Nepal. of Bhutan, and The Karakoram Range, Punjab plains, Thar Desert and Salt marshes of Rann of Kutch in the west touches the Pakistan boundary. In the northeast side Chin hills and Kachin hills, a forested mountain region that separates India from Burma. Bangladesh border and watershed region of Indo-Gangetic Plan lies in the east. The Ganga is the longest river devising in India. The Indian Craton can be divided into five major parts as -- Aravalli Craton, Bundelkhand Craton, Dharwar Craton, Singhbhum Craton and Bastar Craton. India is divided into 6 physiographic such as-- Northern Mountains (Himalayas), Peninsular Plateau (Aravalli, Vindhyanchal and Satpura ranges), Eastern Ghats and the Western Ghats and plateaus (Malwa Plateau, Chhota Nagpur Plateau, Southern Garanulite terrain, Deccan Plateau and Kutch Kathiawar plateau), Indo-Gangetic Plain, Thar Desert, Coastal Plains and Islands (Fig. 1).

The purpose of this study was to obtain information on the past and current distribution of Indian peafowl in India through public participation and contribute to the baseline information. The various Indian conservation societies, groups and foundations work for bird's conservation, and thousands of biologists and citizen scientists worldwide contribute data. These platforms are designed for collecting, presenting and evaluating the diversity of birds from all over the country and other biodiversity hotspots of the World. eBird is a well-known platform working for birds and being used for research and educational purposes by citizen scientists. Citizen science programs were principally considered as educational tools and helpful to collect large data (Brewer, 2002; Brossard et al., 2005; Evans et al., 2005).

## Data collection and statistical analysis:

We have taken the permission request to access the data and after permission, downloaded the comprehensive bird basic dataset and again reduced it to checklists from 2001 to 2017. The checklist of Indian peafowl is based on the spot



Fig. 1: Map of Study area (India) with land use pattern

identifiers event. We excluded the inadequate data and repetitions of identifier and shortening the repetitive data sets. Once estimating population trends for the species, used from eBird locations, as defined by the "locality ID" and GPS locations, with at least one record for the species. The most prominent observing sites were visited for verification. The survey involved questions concerning the species' location, group size, (i.e., the total number of birds present in each sighted group), and current conservation concerns. We also analyzed habitat, population changes for distribution of species that occur in the study area and awareness and concern of local birders, students and the public related to species conservation.

Maps are made using Arc GIS 10.5 software and resulted in various patterns of peafowl; sightings in the country and showing sighting and distribution patterns of peafowl and the comparison of sights in different years. Other statistical data managed by IBM SPSS software version 20.

## **Results and Discussion**

Indian peafowl occurrence and distribution relate to food and water availability and roosting, breeding habitat. The comprehensive dataset of Indian peafowl from 2001-2017 was used to prepare the distribution maps in different years.

From 2001 to 2017 had received 71,632 records from 15,151 contributors across 26 states/union territories of India. Percentage of individuals observed was 38% (in 2017), 27% (in 2016) and 16% (in 2015) whereas 0% was recorded in 2002, 2006 and 2007 (Table 1).

The species was reported both from protected as well as unprotected area like agriculture fields, residential areas, educational campus and small patches of forests. More or less the peafowls were reported either as single birds or in pair or large flocks of less than 125. Peafowl roosts on trees and also uses tall buildings where trees are threatened. It generally prefers a habitat mosaic of scrub and open areas, with adequate sites for sand rinsing and lekking, to congregate in open areas for revealing to attract females (Yasmin and Yahya, 1996, Petrie *et al.*, 1999). The peafowl is broadly dispersed in the Indian sub-continent, from the south and east of the Indus River, Jammu and Kashmir, east Assam, south Mizoram and the entire Indian peninsula (Sabesh, 2010). The fluctuations or changes in population increases progressively (Fig. 2).

The Indian peafowl is widespread in India, and reside in a diverse array of habitats from urban landscapes to forests, protected as well as unprotected areas. Indian peafowl was reported from 26 of the 29 states/7 union territories of India. This is an indication of the wide terrestrial documentation of peafowl from across India. The mean number of most sighted reported states were Tamilnadu (1005.56), Karnataka (472.88), Rajasthan (464.94), Gujarat (427.58), Maharashtra (350.29) and Kerala (321.76). Mean number of individuals of Indian peafowl observed in the various States of India is depicted in Table 2.

The population is very high in Tamilnadu, Karnataka and Rajasthan. The loss of habitat is due to forests destruction, poaching in some of the regions of India, still, the population of peafowl is good in number and sounds positive. Some districts of Tamilnadu (Thoothukkudi, Madurai, Coimbatore, Tiruppur, Salem, Ariyalpur), Karnataka (Chamrajnagar, Mysuru, Dakshina Kannad, Udupi, Dharwad), Rajasthan (Sawai Madhopur, Jaipur, Jaiselmer, Bikaner, Churu), Gujarat (Junagarh, Bharuch, Gandhinagar, Ahmadabad), Maharashtra (Pune, Akola, Jalgaon, Amravati) and Kerala (Palakkad, Thrisur, Malappuram, Kasaragod) have upright population of peafowls. There are more than 50% of the reports of peafowl from the above-mentioned states and districts. Thus, the results show that citizen from these states/districts are more aware and have taken the responsibilities towards biodiversity conservation. It was encouraging to see peafowl reports from states like Sikkim, Bihar,

Table 1: Percentage of the total number of individuals of Indian peafowl and social groups observed in the various states of India

SN	Year	% of State Observed	% of Group Observed	% of Total Individuals Observed
1	2001	4	0	1
1	2001	1	Ŭ	1
2	2002	4	0	0
3	2003	4	1	1
4	2004	6	1	1
4	2004	0	1	1
5	2005	5	1	1
6	2006	4	0	0
Ũ		-	Ŭ	
7	2007	5	1	0
8	2008	5	1	1
9	2009	ς	1	1
,	2007	5	1	1
10	2010	5	1	1
11	2011	6	1	1
10	2012	7	2	1
12	2012	/	Δ	1
13	2013	8	3	2
14	2014	8	8	9
	2011	0		
15	2015	8	16	16
16	2016	8	25	27
17	2017	0	20	20
1/	2017	0	30	30

S.NO	State/Area	Mean number of Individual/±SDx	Variance o2
1	Andhra Pradesh	6.64±12.87	165.87
2	Assam	16.17±42.21	1782.26
3	Bihar	1.11±4.47	19.98
4	Chandigarh	16.70±48.28	2331.03
5	Chhattisgarh	24.76±28.04	786.41
6	Daman & Diu	0.41±1.41	2.00
7	Delhi	169.47±308.56	95214.71
8	Goa	104.70±175.40	30768.32
9	Gujarat	427.58±880.37	775064.71
10	Haryana	126.64±218.47	47730.81
11	Himachal Pradesh	20.58±54.35	2954.71
12	Jammu & Kashmir	6.29±18.88	356.67
13	Jharkhand	1.23±2.86	8.17
14	Karnataka	472.88±901.56	812823.63
15	Kerala	321.76±667.60	445698.88
16	Madhya Pradesh	202.00±407.81	166313.88
17	Maharashtra	350.29±612.48	375134.44
18	Odisha	24.17±59.47	3537.32
19	Punjab	35.05±78.23	6121.23
20	Rajasthan	464.94±590.78	349028.40
21	Sikkim	0.29±0.57	0.32
22	Tamilnadu	1005.56±1924.35	3703156.12
23	Telangana	129.70±240.71	57942.32
24	Uttar Pradesh	166.94±263.05	69198.76
25	Uttarakhand	146.76±253.31	55372.76
26	West Bengal	26.94±44.38	1969.70

Table 2: Mean number of individuals of Indian peafowl observed in the various states of India



Fig. 2: Fluctuation in numbers of Peafowl from 2001-2017

Jharkhand and Daman and Diu, as there is a lack of literature on the presence of peafowl. It indicates that citizens of these states also taking interest in bird watching and its good sign for the pioneer footstep of conservation from these places.

Though citizen science is a wise tool for data collection, but it has its limitations to how the data generated can be understood or used. There are verv limited interpretations on peafowl distribution/presence based on the records. We could not get information about sightings in some parts of India/state for several reasons such as lack of awareness about bird watching, eBird, lack of interest/time. The areas where no reporting or records was found, doesn't mean the absence of birds in that area. To continue to provide broad citywide data on grey peafowl, the eBird has needed to extend as well, adding new routes and locations as required, it also requires further volunteers and citizen science workforces to establish the itineraries (Sullivan et al., 2009; Datta et al., 2018).

GIS Mapping of Indian peafowl indicates that distribution and occurrence of species are

positively correlated with the non-agricultural area i.e. educational and research institute, parks, monuments as well as the green cover of Indian states, means that in the region of greener cover area (parks, reserve forests, monuments) there is more chance of spotting or reporting the bird (Figs. 3–19). About cultivated areas, peafowl feeds on a wide range of crops such as groundnut, tomato, paddy, chilly and even bananas (Johnsingh and Murali, 1978). In the countryside, it is most partial to crops and garden plants.

The study shows that citizen scientist-conduct survey, use camera and GPS efficiently monitor report peafowl communities, concrete management queries and suggest positive effects on volunteers. Where citizen scientists can be recruited to set cameras and GPS on their home/areas, citizen science deals admittance to areas and wildlife surveys, allowing a more complete and representative sample. The possible educational benefits of citizen science to participants are wide-ranging from additions in the knowledge of the natural world to hands-on experience with the scientific method (Evans et al., 2005; Jordan et al., 2011; Forrester et al., 2016).



Fig. 3: Population status and distribution of Indian Peafowl in 2001



Fig. 4: Population status and distribution of Indian Peafowl in 2002



Fig. 5: Population status and distribution of Indian Peafowl in 2003.



Fig. 6: Population status and distribution of Indian Peafowl in 2004.



Fig. 7: Population status and distribution of Indian Peafowl in 2005.





Fig. 9: Population status and distribution of Indian Peafowl in 2007.



Fig. 10: Population status and distribution of Indian Peafowl in 2008.

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Fig. 11: Population status and distribution of Indian Peafowl in 2009.



Fig. 12: Population status and distribution of Indian Peafowl in 2010.



Fig. 13: Population status and distribution of Indian Peafowl in 2011.



Fig. 14: Population status and distribution of Indian Peafowl in 2012.



Fig. 15: Population status and distribution of Indian Peafowl in 2013.



Fig. 17: Population status and distribution of Indian Peafowl in 2015.



Fig. 16: Population status and distribution of Indian Peafowl in 2014.



Fig. 18: Population status and distribution of Indian Peafowl in 2016.



Fig. 19: Population status and distribution of Indian Peafowl in 2017

## Conclusion

Citizen science can largely be defined as the participation of volunteers in science. Over the past decade, there has been a speedy rise in the number of citizen science initiatives. Citizen scientists have surveyed for and monitored a broad range distribution, increasing our understanding of current peafowl status, patterns, and categorizing important sites for conservation/protection. Citizen science provides long-term monitoring with an educational role, essential means of linking wildlife research with wildlife education and recording. Results from the studies by citizen scientists can be important in identifying key areas of ecological significance within a city and track the pattern of land use. This data can also be used to study the population trends and even to perform occupancy modeling, identify the species "abundance hotspots" and habitat modeling of peafowl species in India.

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