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RESEARCH ARTICLE

RELATIONSHIPS OF MIGRATORY WATER BIRD COUNTS OF EASTERN INDIA WITH FOOD HABITS, METEOROLOGICAL ASPECTS AND DEMOGRAPHIC ASPECTS

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ABSTRACT

Distribution of migratory water birds was conducted in six major wetlands of Eastern India. Relationships of migratory water bird counts with food habits, meteorological aspects and demographic aspects were studied thoroughly in each of the selected wetlands.

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INTRODUCTION

Six wetlands such as Tilpara reservoir, Bakreswar reservoir, Tank1, Tank2 and Tank3 of Birbhum district and Purbasthali of Burdwan district of Eastern India have been studied for the present work. All these wetlands of Eastern India have been visited several times in the span of last few years. Relationships of migratory water bird counts with food habits, meteorological aspects and demographic aspects have been found out in each of the selected wetlands.

MATERIAL AND METHODS

All the selected wetlands have been visited several times in the span of last few years. Purbasthali wetland of Burdwan district of Eastern India is a natural wetland which is an oxbow lake whereas the five wetlands of Birbhum district of Eastern India namely Tilpara, Bakreswar, Tank 1, Tank 2 and Tank 3 of Ballavpur Wildlife Sanctuary are man made wetlands. During the visit to these wetlands, water bird counts have been performed in the middle of January every year. Birds were observed by using a binocular and they were identified by following the methodology of Grimmet *et al*. (2001) and Ali and Ripley (2001).

Relationships of migratory water bird counts with food habits, meteorological aspects and demographic aspects have been found out in each of the selected wetlands. Number of molluscs and macrophytes are calculated by quadrat method in case of six wetlands (Tilpara, Bakreswar, Tank1, Tank2, Tank3 and Purbasthali). Modelings have been done with the help of MINITAB software.

RESULTS

Year wise average number of 14 migratory water birds is shown in Table 1. Migratory birds have started coming from the year 2006 in Tank1 and in case of Tank2 of Ballavpur Wildlife Sanctuary of Eastern India, migratory birds have started coming from the year 2008. In 2010 there were no migratory birds in Tank3 due to mist netting because of bird flue.

Meteorological parameters like total rainfall and minimum mean temperatures of Birbhum and Purbasthali are studied for the years 2004 to 2010. Rainfall data and minimum mean temperature data used in the Table 2 and Table 3 respectively are taken from the Bureau of Applied Economics and Statistics department of Statistics and Programme Implementation of Government of West Bengal.

Total rainfall is average rainfall of 12 months of every year whereas minimum mean temperatures are of the months of November, December, January and February because migratory birds come here only for these 4 months.

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Table1 Year wise average of 14 migratory water birds taken over the wetlands

Year	Tilpara	Bakreswar	Tank1	Tank 2	Tank3	Purbasthali
2004	7240	1630	0	0	5521	3312
2005	4379	1612	0	0	994	3218
2006	2137	886	270	0	2024	2450
2007	2762	1219	616	0	4588	1672
2008	4716	5238	208	170	2864	1215
2009	3272	1984	38	264	4424	962
2010	4531	3280	91	0	2896	231

Table 2 Total rainfall (in mm) of Birbhum and Purbasthali

Location	2004	2005	2006	2007	2008	2009	2010
5 Wetlands of Birbhum	122.6667	105.3333	133.75	142.5833	130.0833	82.08333	123.5
Purbasthali	99.41667	102	120.5	151.0833	135	102.4167	71.33333

Table 3 Minimum Mean Temperature (in ˚C) of Birbhum and Purbasthali

Location	2004	2005	2006	2007	2008	2009	2010
5 Wetlands of Birbhum	14.5	13.75	14.25	9	11.25	9.25	9.75
Purbasthali	15.5	14.5	14.5	10.25	11.75	9.67	10.75

In case of all the six wetlands (Tilpara, Bakreswar, Tank1, Tank2, Tank3 and Purbasthali), quantities of molluscs, fishes and macrophytes are shown in the following table below:

Table 4 Quantities of molluscs, fishes and macrophytes of the studied wetlands

Name of Wetlands	Molluscs /unit area	Fishes/unit effective area **	Macrophytes / unit area
Tilpara	4×10^7	39.85	15.5
Bakreswar	10×10^7	38.84	10.45
Tank1	0.06×10^7	36.83	7
Tank2	0.03×10^7	36.83	31.25
Tank3	0.08×10^7	36.83	44.9
Purbasthali	6×10^7	407.84	10

N.B. ** (Sources: Assistant Director of Fisheries, Burdwan & Birbhum)

Food Modeling

For modeling of the food habits of migratory birds by taking yearly average number of birds of different wetlands as responses and amount of macrophytes, molluscs and fishes as the regressors, several models have been tested by trial and error method and consequently monitored them with the corresponding R^2 value which is the indicator of the efficacy value of the corresponding model. In course of a thorough search, finally it is found that –

1. Average number of birds is not significantly dependent on the quantity of fishes
2. Average number of birds is significantly dependent (at least at 5% - 10% level of significance) on the quantity of macrophytes and molluscs through apparently non-conventional functional dependence described through the following model -

$$y = \text{constant}.\ (\ln x_1{}^{\beta_1}).\ (\ln x_2{}^{\beta_2}).\ e^{u}$$

Where y = average number of birds with respect to years

x_1 = average quantity of macrophytes /quadrat

x_2 = average quantity of molluscs /unit area

u = random error/ disturbance term usually used in statistical model (with normal distribution assumption).

A comparatively presentable form of the above model is indeed –

$$\ln y = \text{constant} + \beta_1 (\ln x_1) + \beta_2 (\ln x_2) + u$$

Positive values of β_1 and β_2 indicate that amount of macrophytes as well as molluscs have positive impact on the bird counts. In other words, the number of birds will significantly increase with the increment in these two food resources.

From MINITAB 16 software findings obtained are as follows:

Regression Analysis: lny versus lnlnX_1, lnlnX_2

Pearson correlation of molluscs and macrophytes= -0.548
P-Value = 0.260

This implies there is no multicollinearity in the covariates.

The regression equation is
$\ln y = 0.29 + 4.44\ \ln\ln X_1 + 1.91\ \ln\ln X_2$

Predictor	Coef	SE Coef	T	P
Constant	0.293	1.717	0.17	0.876
lnlnX_1	4.436	1.412	3.14	0.052
lnlnX_2	1.9087	0.4576	4.17	0.025

R^2= 86.8%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	10.6602	5.3301	9.87	0.048
Residual Error	3	1.6194	0.5398		
Total	5	12.2796			

Source	DF	Seq SS
lnlnX1	1	1.2674
lnlnX2	1	9.3928

Meteorological Modeling

For modeling of the meteorological aspects**,** yearly average number of birds of different wetlands is taken as responses and total rainfall and mean minimum temperature as the regressors. Rainfall data and mean minimum temperature data are taken from Table 2 and Table 3 respectively. In addition to minimum temperature and rainfall, maximum temperature is also supposed to affect the bird counts. But it is found that maximum temperature is highly correlated with minimum temperature (Pearson Correlation of minimum temperature and maximum temperature is = - 0.829, p=0.00) implying that maximum temperature can be determined from linear relation with minimum temperature and hence prediction of bird count would suffer from the problem of multicollinearity, if maximum temperature would also be involved in the model as an additional covariate. The presence of multicollinearity may reduce the efficacy of the model and even may lead to misleading conclusions. To avoid this unwanted situation maximum temperature covariate has not been considered in this modeling. Minimum temperature is much more decisive for variation in bird counts than maximum temperature since migratory birds come in the studied wetlands only for three months during winter.

From software MINITAB 16 findings obtained are as follows:

Regression Analysis: lnlny versus lnr, lnlnr, ...

The regression equation is

$$lnlny = 3975 - 33217\ lnr + 105045\ lnlnr - 45104\ lnlnr^2 + 26539\ lnlnr^3 - 320\ tMin + 54.0\ tMin^2 - 4.51\ tMin^3 + 0.186\ tMin^4 - 0.00306\ tMin^5$$

Predictor	Coef	SE Coef	T	P
Constant	3975	3749	1.06	0.349
lnr	-33217	21874	-1.52	0.203
lnlnr	105045	66273	1.59	0.188
$lnlnr^2$	-45104	27846	-1.62	0.181
$lnlnr^3$	26539	17071	1.55	0.195
tMin	-320.5	236.2	-1.36	0.246
$tMin^2$	53.99	39.76	1.36	0.246
$tMin^3$	-4.506	3.317	-1.36	0.246
$tMin^4$	0.1864	0.1371	1.36	0.245
$tMin^5$	-0.003058	0.002245	-1.36	0.245

R^2= 85.3%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	9	0.128691	0.014299	2.59	0.187
Residual Error	4	0.022093	0.005523		
Total	13	0.150784			

Demographic Modeling

Demographic data like total population and number of tourists of the years 2004 to 2010 of Purbasthali and Birbhum has been collected from Bureau of Applied Economics and Statistics department of Statistics and Programme Implementation of Government of West Bengal. Demographic Models are done separately for Birbhum and Burdwan because studying them separately is more logical and realistic as the human impacts like total population and number of tourists may affect the number of birds in two districts in two different ways unlike meteorological modeling because there is hardly any change in meteorological parameters of two almost adjacent districts. Table 5 and Table 6 are showing the total population and number of tourists which are as follows:

Table 5 Total Population and number of tourists of Birbhum

Total Population of Birbhum (IntcenBir)	Number of Tourists of Birbhum (tour_Bir)
3152721	17032
3199862	14819
3247709	19872
3296271	17441
3345559	14342
3395584	14217
3446357	28628

Total population of Birbhum and Burdwan of the year 2001 and 2011 has been obtained from Bureau of Applied Economics and Statistics department of Statistics and Programme Implementation of Government of West Bengal. Intercensal population estimate of the years 2004 to 2010 has been calculated by G.P. (Geometric Progression) method which is as follows:

$P_t = P_0\ (P_1/\ P_0)^{\ t}$ where
P_0 = Population of the year 2001
P_1 =Population of the year 2011
P_t = Population at time t.

Therefore estimated population at the year 2004 = P_t at t which is equal to 3/10 etc.

Table 6 Total population and number of tourists of Burdwan

Total Population of Burdwan (IntcenBurd)	Number of Tourists of Burdwan (tour_Burd)
7133983	8567
7215291	11526
7297526	13087
7380698	14231
7464819	8405
7549898	11297
7635946	12366

For Demographic modeling**,** yearly average number of birds of different wetlands is taken as responses and total population and number of tourists as the regressors.

Birbhum

Correlations: tour_Bir, IntcenBir

Pearson correlation of tour_Bir and IntcenBir = 0.236
P-Value = 0.611

This implies there is no multicollinearity in the covariates under Birbhum.

Regression Analysis: y (Birbhum) versus tour_Bir, IntcenBir, ...

The regression equation is

y (Birbhum) = 931769 - 1.44 tour_Bir - 0.549 IntcenBir + 0.000033 $tour\_Bir^2$
+ 0.000000 $IntcnsBir^2$

Predictor	Coef	SE Coef	T	P
Constant	931769	198885	4.68	0.043
tour_Bir	-1.4439	0.4029	-3.58	0.070
IntcenBir	-0.5486	0.1205	-4.55	0.045
$tour\_Bir^2$	0.00003276	0.00000950	3.45	0.075
$IntcnsBir^2$	0.00000008	0.00000002	4.50	0.046

R^2= 95.4%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	4	6662720	1665680	10.40	0.090
Residual Error	2	320378	160189		
Total	6	6983098			

Burdwan

Correlations: tour_Burd, IntcenBurd

Pearson correlation of tour_Burd and IntcenBurd = -0.365
P-Value = 0.421

This implies there is no multicollinearity in the covariates in case of Burdwan

Regression Analysis: y(Burdwan)_1 versus tour_Burd, IntcenBurd

The regression equation is

y (Burdwan)_1 = 46272 + 0.0697 tour_Burd - 0.00612 IntcenBurd

Predictor	Coef	SE Coef	T	P
Constant	46272	2876	16.09	0.000
tour_Burd	0.06972	0.03398	2.05	0.109
IntcenBurd	-0.0061240	0.0003669	-16.69	0.000

R^2 = 98.9%

Analysis of Variance

Source	DF	SS	MS	F	P
Regression	2	8120259	4060130	177.50	0.000
Residual Error	4	91494	22874		
Total	6	8211753			

DISCUSSION

Quantities of macrophytes as well as molluscs have positive impact on the bird counts. In other words, the number of birds will significantly increase with the increament in these two food resources. Average number of birds is not significantly dependent on the quantity of fishes whereas it is significantly dependent (atleast at 5% - 10% level of significance) on the quantity of macrophytes and molluscs. As in usual practice, the bird count model on the meteorological covariates like rainfall and minimum temperature is quite complex. If bird count is expressed in lnln scale then it is found to be dependent on rainfall in ln scale, rainfall in lnln scale with at least third degree polynomial and also dependent on minimum temperature through five degree polynomial.

The partial regression coefficient of lnr is – 33217 which means as the rainfall increases in ln scale bird count decreases in lnln scale and moreover the rate of increment is – 33217. Similarly, it can be interpreted for other partial regression coefficient values. Unlike some simple dependence models such as linear, quadratic etc. here the scenario is not so simple to conclude a steady increment or decrement patterns of bird counts with respect to increment or decrement of rainfall (r), rather the rainfall in different levels may have different types of impacts on the bird counts. For example, if rainfall is low enough such that lnlnr is a positive fraction the impact of lnlnr is much more dominant compared to the impacts of $lnlnr^2$ or $lnlnr^3$.

Further impact of lnr is more deciding relative to the impact of lnlnr. But the scenario may change if the r value is quite high such that lnlnr is > 1. Similar argument can be laid in support of the bird count with respect to minimum temperature. However, the model can adequately serve the purpose of predicting the bird counts from meteorological perspectives as the R^2 value which is the measure of efficacy of the above model is 85.3% which is quite high.

In case of demographic modeling of Burdwan, the number of birds will significantly decrease with the increase in total population because here p (probability) value is 0.00 which is less than 0.05. Number of birds is not significantly dependent on the number of tourists even at 10% level of significance. This model can efficiently predict the bird counts from demographic perspectives as the R^2 value is 98.9% which is very high.

In case of demographic modeling of Birbhum, bird count is found to be dependent on number of tourists and total population with at least second degree polynomial. The partial regression coefficient of tour_Bir (number of tourists of Birbhum) is -1.44 which means as the number of tourist increases, bird count decreases. Similarly, it can be interpreted for other partial regression coefficient values regarding the other non-linear functions of tour_Bir.

The partial regression coefficient of IntcenBir (total population of Birbhum) is -0.549 which means as the total population increases, bird count decreases. Similarly, it can be interpreted for other partial regression coefficient values regarding the other non-linear functions of total population of Birbhum. This model can efficiently predict the bird counts from demographic perspectives as the R^2 value is 95.4% which is very high.

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References

Ali, S. and S. D. Ripley. (2001). Handbook of Birds of India and Pakistan (Vol: 1 & 2). Oxford University Press, New Delhi.

Grimmett, R, C. Inskipp and T. Inskipp. (2001). Pocket Guide to the Birds of Indian Subcontinent. Oxford University Press, New York.

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