Impact of Migratory Birds on the Wetland Ecosystem with special reference to the Nutrient Load and Primary Productivity of an Urban Wetland : A Preliminary Study

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ABSTRACT

Wetland ecosystems are considered as a closed ecosystem in which different varieties of life grow and decomposes. It is a transitional area characteristic of terrestrial and aquatic ecosystems. The productivity and characteristic of a wetland constantly are in a status of flux because of dynamic biotic and abiotic factors. The type and quantity of nutrients that enter and exit wetlands through external factors vary among location, seasons and years. The migratory birds and animals are one of such factors responsible to change the nutritional status and productivity of wetlands. The present study is focused on the nutrient load on the wetlands due to the migratory birds. Mainly three chief nutrients viz. phosphorus, nitrogen and sulfur were estimated during pre migratory, migratory and post migratory seasons by collecting the water samples. Primary productivity of these water samples were also estimated to know the impact of nutrient load on the primary productivity and other functions of a wetland ecosystem. The data were analyzed through student's't' test and correlation analysis to know the significances of nutrient loading during the migratory season. The study shows that the nutrient like phosphorus increases with increase in the migratory bird number and are positively correlated with the primary productivity. This preliminary study also suggests that the life forms in an urban wetland, human interference and the migratory bird communities are collectively affect the self sustainity of a wetland ecosystem.

INTRODUCTION

The wetlands encompass diverse and heterogeneous assemblage of the habitats. Abundance of water at least for a part of the year is the single dominant factor, which provides habitat to the local as well as migratory birds. Migratory birds serve as one of the indicators to know nutrient balance, productivity and self sustainity of a wetland. Migratory birds and its assemblage with other components of wetland may also provide several ideas for better wetland monitoring and management. They also serve as nutrient sinks and nitrogen limitation would be the major regulator of productivity (DeLuane et al.1986). Birdborne nutrients alter the productivity and nutrient level in these ecosystems. We do not know the magnitude of those effects, but we can imagine that they would be locally variable. Very few studies on the impact of migratory birds on nutrientional balance

and primary productivity of wetland have been done in this area. There is rapid growth in the general view of the importance of mobile consumers and their contribution to local nutrient cycles (Kitchell et al. 1999; Carpenter and Kitchell 1993). There are also concerns that birds can contribute to eutrophication problems in lake (Hoyer and Canfield, 1994) hence it is very necessary to examine the potential of bird populations to contribute to the nutrient load in a wetland ecosystem. Hoyer and Canfield (1994) also found that bird abundance and species richness is increased on eutrophic lake because productive lakes have greater food resources. Thus it seems very crucial to monitor the closed ecosystems like lakes and ponds with reference to birds abundance, nutrient load and consumption which may provide suitable guidelines for further measures for restoration, conservation and management of lakes.

The region of north Gujarat is semi arid to arid land with some very important wetlands which are visited regularly by migratory water fowls. Being a semi arid zone water scarcity has also elicited people to build village ponds and check dams as a watershed management and conservation, such water bodies are also providing habitats for variety of resident and migratory water birds (Gajera 2007). The region of North-Central Gujarat is falls on the migratory route of many wintering migrants and hence it is very important to monitor both bird community as well as the ecological status of a wetland for successful conservation of migratory birds and wetland ecosystem. There are many field notes, checklists and few scientific papers and reports have been recorded from this area as a research work but very little work is done so far through which one can prepare proper planning for conservation and management of these important wetlands and lakes. Index of bird community integrity has been carried out for the wetlands of North-central Gujarat (Sejal and Nishith, 2008) has also suggested the urgent need for wetland management plan for wetland conservation in this area. A proper management and restoration of any ecosystem requires all the information regarding its biotic and abiotic components, interaction among them and systematic and scientific monitoring of such interacting components.

Looking to the immediate needs of having a management plan for wetlands of North Gujarat, the study have been started with several objectives such as to list migratory birds, to study hydrology of wetlands, monitoring of bird community, study of community integrity and impacts of migratory birds on the wetland ecosystem. We have identified more than 50 wetlands in the region for this study which may provide baseline data and important information by which some concrete conservation measures can be taken for management and restoration of wetlands in the area. The present work is a pilot study of a long term research project on wetland status of North Gujarat. The study presents total bird count in different season and bird's contribution to nutrient loading which ultimately affect the primary productivity of a wetland.

STUDY AREA

The study are of this long term project is entire North Gujarat region (biogeographic

zone 4- the semi arid and into biotic province 4B of the Gujarat Rajwada) encompassing four districts viz. Mehsana, Banaskantha, Sabarkantha and Patan; for the present research work we have selected one urban wetland of Sujnipur village of Patan district as a pilot plot to study. This is urban wetland is one of the most disturbed wetlands by human interference in the region. The wetland is spread in about 3 km^2 surrounded by several agricultural farms and one temple for worship. People from 2 nearby villages are reported using this lake for many different domestic uses. The water is alkaline in its chemical nature. But this wetland support about 40 local and 18 migratory species. The submerged vegetation shows very less diversity where as the surrounding vegetation is mainly composed of Azardirachta indica (Neem), Acacia nilotica (Desi baval), Ziziphus species and Salvadora Species (Pilu) along with some terrestrial herbs and grasses which serve as a habitat for birds and other wild animals like Blue bull (Boselaphus tragocamelus), Indian hare (Lepus nigricollis), Jackal (Canis aureus), Jungle cat (Felis chausa), etc. It has been reported that the submerged vegetation increases in monsoon and decreases during pre migratory and migratory seasons. Planktons are abundant in water which may play an important role in sustaining productivity of a lake.

METHODS

Sujnipur village pond locally known as Jogini Talab was selected for the data collection site for this pilot study due to its less distance from Patan city. The pond area is divided into three different sites for bird observation and collection of water samples. Each site was visited during August-December 2007 (Migratory Season) and January-July 2008 (Post and Pre Migratory Season). Time of observations and data collection were maintained from 8:00 to 12:00 am in the morning and 3:00 to 6:00 pm in the afternoon at regular interval of 20 days per month. At each site bird count was made by point count method through identification and counting using a pair of binoculars. Bird species and their number of individuals were counted and recorded in suitable performa. The Birds species were further categorized into resident, migratory, and resident breeding according to their residential status using standard references (Parasharya et al. 2004, Grimmette, 1999).

Water samples were collected from various sites of the lake marked with collection details and stored in air tight bottles at 4 ^0C for further laboratory analysis. The samples were collected through pre migratory, migratory and post migratory seasons. Three chief nutrients viz. Nitrogen, Phosphorus and Sulfur were estimated from each sample for the present study. All the nutrients in the water sample were estimated by standard methods as described in (APHA, 1998). Moreover the primary productivity in the collected water samples were also estimated using Light and Dark bottle BOD method.

Student's 't' test and simple linear correlation analysis was employed as a statistical methods (Zar, 1999) to know the statistical significance of increase in nutrient level through different seasons and correlation of the data collected of migratory bird species and nutrient load in the wetland respectively. The conclusions were made according to the statistically analyzed data and observation tables.

RESULTS AND DISCUSSION

The pond included in this study encompassed a wide range of limnological conditions. Total 57 species of birds were recorded belonging to 29 families, out of which 33 species belonging to 11 different families were wetland obligatory bird species. In case of wetland obligatory species 17 were local and 16 were migratory waterfowls. The local bird species includes Indian black ibis (Pseudibis papillosa), Painted stork (Mycteria leucocephala), little tern (Sterna albifrons pallas), etc. Where as among the migratory bird species, Bartailed godwit (Limosa lapponica), Eurasian wigeon (Anas penelope), Wood sandpiper (Tringa glareola), Common pochard (Ayphya ferina), Northern shoveller (Anas clypeata), etc were recorded during the study period. The detail checklist is given as appendix 1.

Out of total birds species recorded, 29 were recorded in pre migratory season; 57 in migratory season and 31 species were recorded in post migratory season (Table 1). The species composition at the lake in migratory season depicts the assemblage of all migratory species (35%), resident breeding species (53%) and resident and resident migrants 6% each (Figure 1). Figure 1 also reveals that the number of migratory birds in the lake is seems higher in comparison to the total catchments area of lake. Another lake in this region with 6 km^2 area has recorded 27 migratory bird species (Sejal et al. 2006). Looking to the area of a lake and number of migratory birds, it can be said that there may be significant amount of nutrients released in the migratory season through bird's excreta. Three chief nutrients viz. Phosphorous, Nitrogen and Sulfur have been estimated during all the seasons respective to bird assemblage and recorded as Table 2.

Table 2 shows that the amount of all the nutrients estimated are significantly different in three seasons respective to bird assemblage (t = 0.079, p<5%, n=5). During the migratory season, the amount of nutrients exceeds up to almost double than that of the pre migratory season and are significantly reduces in the post migratory season which reflects its consumption by the other biotic components in a lake. This variation in the nutrient content may play a key role in sustaining this highly disturbed wetland. Moreover it is also assumed that the nutrient level may decreases constantly in absence of migratory birds in the migratory season. Table 2 also depicts the important role of migratory birds in nutrient cycling of such a small wetland ecosystem.

Further, nutrient variations are significantly correlated to bird numbers in all the season (Figure 2). Figure 2 also reveals that phosphorus concentrations are highly correlated with bird assemblage (r^2= 0.87) that is followed by Nitrogen (r^2= 0.72) and Sulfur (r^2= 0.68).Kitchell 1999 have also reported that 75% of the phosphorous is added in wetland ecosystem through the excreta of Geese out of 60% of their consumed nutrients. He has found that total phosphorous concentrations were higher in water during the season in which high number of geese recorded in the wetland. This shows that the high concentration of phosphorous estimated is mainly due to the migratory birds. The

Table 1 : Number of bird species recorded in various seasons

No	Season	Total # Bird species	Migratory	Non Migratory*
1	Pre migratory	29	5	24
2	Migratory	57	21	36
3	Post migratory	31	8	23

** Non migratory includes Resident, Resident breeding and Resident breeding*

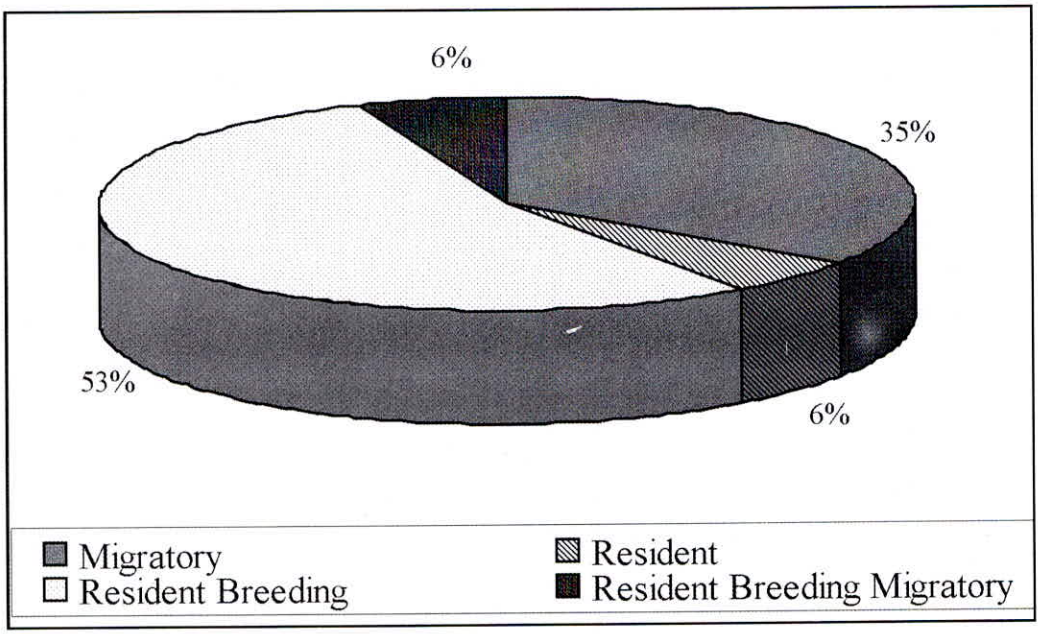

Fig. 1: Different bird species recorded in the migratory season

Table 2: Level of chief nutrients in various seasons

No	Season	Nutrient Level (mgl^{-1})		
		P	N	S
1	Pre migratory	1.466	5.93	0.08
2	Migratory	2.293	12.46	0.186
3	Post migratory	1.69	9.266	0.11

P: Phosphorous, N: Nitrogen, S: Sulfur

nutrient level may also change in the lake due to agricultural runoff and other human interference from the vicinity as the lake studied is surrounded by agricultural farms and two villages.

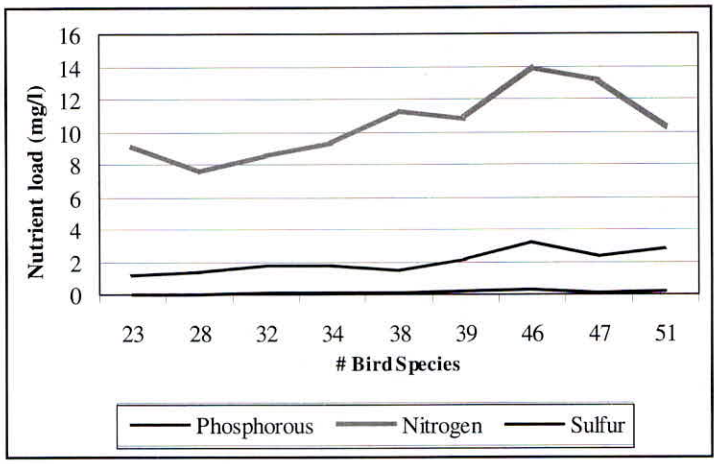

Fig. 2: Correlation between bird species and lake nutrient level

The overall study shows that the migratory birds are playing a vital role in cycling the nutrients in a closed wetland ecosystem through the deposition of their consumed food by excreta; which in turn consumed by the primary producers and consumers like aquatic plants and planktons respectively through which the nutrient balance and sustainity of a wetland ecosystem is maintained. We have also found comparatively high gross primary productivity of a lake during the post migratory season (9.4 mg/m^3/hr) than that of the pre migratory season (8.75 mg/m^3/hr), which shows the consumption of added nutrients by the primary producers during the post migratory season. It is also felt necessary to study the presence of aquatic macrophytes in the lake systems and to workout their biomass and chlorophyll levels as studied by kitchell et al. (1999), which will give the clear picture of nutrient cycling in the ecosystem and sustainity of a lake ecosystem.

The present study gives a clear idea that the bird abundance is positively correlated with the nutrient load as well as the primary productivity of a lake. The study also depicts that the number of migratory birds are higher with respect to the lake area and human disturbance. The decrease in the primary productivity and nutrient level in post migratory season reveals the presence of aquatic macrophytes in the lake during all the season which is responsible for consumption of nutrients and preventing the lake from eutrophication. In the next phase of the research work the aquatic macrophytes, their biomass and their role in sustaining the lake ecosystem will be carried out. The entire work will be employed further to all other identified wetlands of the North Gujarat region to prepare monitoring measures and conservation action plan.

Appendix 1 :
Checklist of birds recorded during the study period in the study site

No	Common Name	Scientific Name	R. Status
	Grebes: podicipedidae		
1	Little grebe	*Tachybaptus ruficollis*	RB
	Herons, Egrets: Ardeidae		
2	Grey heron	*Cinerea cinea linnaeus*	M
3	Pond herron	*Ardeola grayii*	RB
4	Cattle egret	*Bubulcus ibis*	RB
5	Little egret	*Egretta garzetta*	RB
6	Large egret	*Casmerodius albus*	RB
	Storks: Ciconiidae		
7	Painted stork	*Mycteria luecocephala*	RB
8	White stork	*Ciconia ciconia*	M
9	White nacked stork	*Ciconia episcopus*	RB
	Ibises&Spoonbills: Threskiornithidae		
10	Black ibis	*Pseudibis papillosa*	RB
11	Eurasian Spoonbill	*Plataea leucorodia*	RB,M
	Ducks: Anatidae		
12	Gray lag goose	*Anser anser*	M
13	Lesser whistling teal	*Dendrocygna javanica*	RB
14	Northern pintail	*Anas acuta linnaeus*	M
15	Common teal	*Anas falcate georgi*	M
16	Spotbill duck	*Anas poecilorhyncha*	RB
17	Wigeon	*Anas penelopa*	M
18	Northern shoveller	*Anas clypeata*	M
19	Common pochard	*Aythya ferina*	M
20	Comb duck	*Sarkidiornis melanotos*	RB
	Kites: Accipitridae		
21	Brahminy kite	*Haliastur indus*	RB
	Pheasants: Phasianidae		
22	Common peafowl	*Pavo cristatus linnaeus*	R
	Lapwings: Charadriidae		
23	Redwattled lapwing	*Vanellus indivus*	RB
	Sandpipers, Stints, Godwiys: Scolopacidae		
24	Bartailed godwit	*Limosa lapponica*	M
25	Spotted redshank	*Tringa erythropus*	M
26	Common redshank	*Tringa totanus*	M
27	Marsh sandpiper	*Tringa stagnatilis*	M
28	Wood sandpiper	*Tringa glariola*	M
29	Common sandpiper	*Actitis hypoleucos*	M
30	Ruff	*Philomachus pugnax*	M
	Avocets, stilts:Recurvirostridae		
31	Pied avocet	*Recurvirostra avocetta*	RB,M
32	Blackwinged stilt	*Himantopus himantopus*	RB
	Terns: Laridae		

Appendix 1 :
Checklist of birds recorded during the study period in the study site (contd...)

33	Common tern	*Sterna hirundo linnaeus*	M
34	Little tern	*Sterna albifrons pallas*	RB
	Pigeons & Doves: Columbidae		
35	Blue rock pigcon	*Columba livia*	RB
36	Indian ring dove	*Streptopelia senegalensis*	RB
	Prakeets: Psittacidae		
37	Rosering parakeet	*Psittacula krameri*	RB
	Cuckoos: Cuculidae		
38	Common hawk cuckoo	*Hierococcyx varius*	RB
39	Asian Koel	*Eudynamys scolopacea*	RB
	Swifts: Apodidae		
40	Common Swift	*Apus apus*	M
	kingfishers: Alcedinidae		
41	Whitebreasted kingfisher	*Halcyon smyrnensis*	RB
	Bee-eaters: Meropidae		
42	Small bee-eater	*Merops orientalis*	RB
	Hoopoes: Upupidae		
43	Hoopoe	*Upupa epops*	M
	Barbets: Capitonidae		
44	Brown headed barbet	*Megalaima zeylanica*	RB
	Woodpeckers: Picidae		
45	Rufous woodpecker	*Celeus brachyurus*	R
	Swallows: Hirundinidae		
46	Common swellow	*Hirundo ristica linnaeus*	M
	Drongos: Dicruridae		
47	Black drongo	*Dicrurus macrocercus*	RB
48	Gray drongo	*Dicrurus leucophaeus*	M
	Starlings, Mynas: Sturnidae		
49	Rosy Starling	*Sturnus roseus*	M
50	Common myna	*Acridotheres tristis*	RB
	Crows: Corvidae		
51	House crow	*Corvus splendens*	RB
	Bulbul: Pycnonotidae		
52	Red vented bulbul	*pycnonotus cafer*	RB
	Babblers: Timaliinae		
53	Common babbler	*Tordoides caudatus*	RB
54	Jungle babbler	*Turdoides striatus*	RB
	Sunbirds: Nectarinidae		
55	Small sunbird	*nectarini minia*	R
	Sparrows: Passerinae		
56	House sparrow	*Passer domesticus*	RB
	Weavers: Ploceinae		
57	Bayaweaver	*Ploccus philippinus*	RB

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