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Impact of Windmills and Power lines on Birds: A case study at Porbandar Taluka, Gujarat-India

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Abstract

A great number of birds are killed each year through electrocutions and collisions with power lines and windmills globally. Windmills and associated power lines located near some important wetlands (Important Bird Area) of Porbandar taluka, Gujarat state is surveyed from May 2016 to January 2017. During present study, total 111 species of birds belong to 42 families, which include 11 IUCN threatened species (4 VU, 7 NT). Of all birds 73 species (66%) represent aquatic and 39 species (35%) migratory, this indicates the ecological importance of the landscape. The results show that collision and electrocution of birds by power lines and windmills is of conservation concern in Porbandar with Pelicans, Storks, Cranes, Pea-fowls and Raptors as the most affected species. Preliminary findings of this study confirm the possible impact of wind turbines and Power lines on birds in Porbandar Taluka.

Keywords: Porbandar, Wetland, Windmill, Collision, Electrocution

1. Introduction

Wind-generated electricity is renewable and generally considered environmentally clean (Gipe, 1995; Redlinger *et al.*, 2002) ^[1, 2]. Harnessing wind energy is an affordable form of power generation that is pollution-free with comparatively less environmental impacts (Osborn *et al.*, 2000) ^[3]. Although, corridors of Power lines and windmills affect different groups of animal, predominantly birds. These impacts are largely associated with fragmentation and degradation of natural habitat of wildlife (Askins *et al.* 2012) ^[4], natural vegetation that is removed to construct approach road to reach windmills and power lines, and another cause reported is Electrocutions, collisions and mortalities of Birds. Windmills and Power lines located close to some important bird areas (IBA), like water bodies which have large congregation of birds and bisecting critical paths, pose a significant risk of electrocution or collision in birds. Wind farms affect birds mainly through collision with turbines and associated power lines (Drewitt and Langston, 2006; Lekuona and Ursua, 2007) ^[5, 6] or disturbance displacement (Drewitt and Langston, 2006) ^[5]. Observed impacts vary geographically due to varying topography, habitat, weather conditions, bird flyways, species diversity and species abundance (GAO, 2005) ^[7].

In India, several wind farms are commissioned or are under construction especially in those areas where wind resource is plentiful. The long coastline and suitable environment of Gujarat state and especially Porbandar district of Saurashtra coastline support good number of windmills.

In recent years studies on, on the impact and mortality of birds and caused by wind turbines and power lines in different countries like USA, UK, Canada, New Zealand, Ireland, Denmark, Spain, Belgium and Australia is available. However, the impact of wind farms and power lines on birds is very less studied with very few workers in Gujarat with emphasis on electrocutions and collision of birds especially on Lesser and Greater Flamingoes (*Phoeniconaias minor* and *Phoenicopterus roseus*) B.M Parasharya. Anika tere and I. R. Ghadhavi (sight papers). The present paper discusses on the avifaunal diversity around the wind farms sites of Porbandar Taluka and its impact on birds.

Study Area

The general terrain of Porbandar district is plain with slope from Barda hills to the sea-coast intermixed with tracks of marshy land known as "Ghed". About 226 wetlands are mapped in Porbandar district including 95 small wetlands (< 2.25 ha) covering an area of 22199 ha.

Inland wetlands contribute 27.3% of the total wetland area and coastal wetlands contribute 72.7% of the total wetland area (Vargiya *et al.* 2015) [8]. Present study is carried out to cover all the major and important wetland of Porbandar *taluka* of Gujarat. Mokarsagar Wetland Complex (previously known as Gosabara), is declared as Important bird area (IBA) in April, 2017 and includes cluster of wetlands viz., Medha creek,

Kuchhadi, Subhashnagar, Zavar, Karly I, Karly II, Vanana, Dharampur, Gosabara, Bhadarbara, Mokarsagar, Bardasagar and Amipur wetlands (Fig.1). The Study area attracts numerous migratory birds because of strategic position in the path of Central Asian migratory flyway (Fig 1). The Central Asian Flyway is among the shortest flyways in the world, where it connects a large swathe of the Palaeartic with the Indian subcontinent.

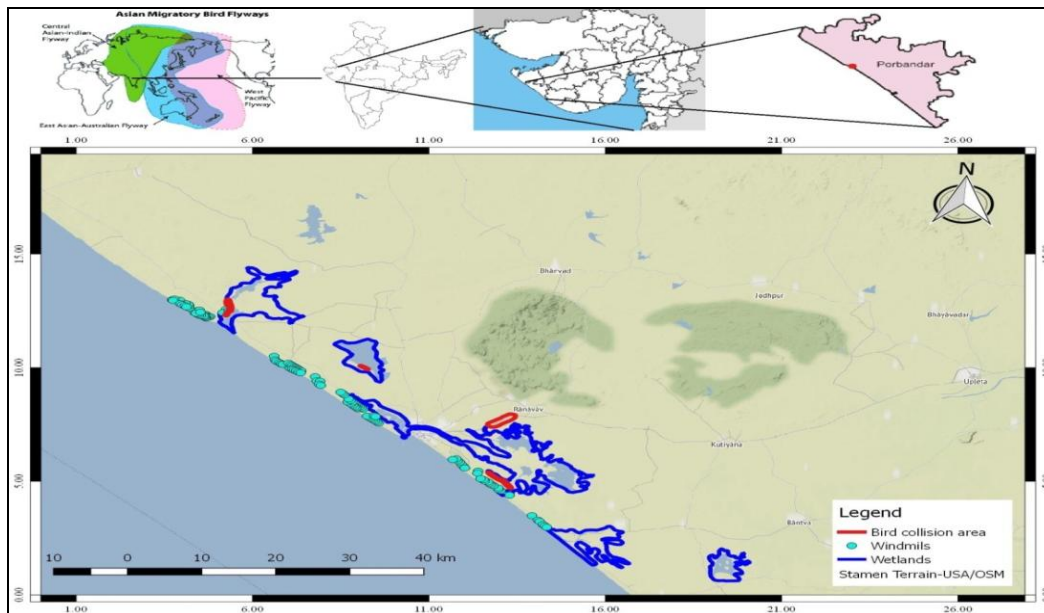


Fig 1: Locations of Windmills, Important Wetlands and Identified Bird Collisions and mortality areas

Methodology

Surveys of wetland and terrestrial birds’ is conducted once in each season viz. summer, monsoon and winter from May 2016 to January 2017, total count method (Bibby *et al.*, 2000) [9] and line transect method (Gaston 1975) [10] was done to estimate the species composition at study areas. Mortalities of birds due to Collisions and Electrocutations with windmills and power lines was observed and recorded in study areas, species name and GPS locations was recorded. The birds observed through a 10 X 50 range binocular and photography was done with the help of SONY and CANON Digital Camera with zoom lens. Birds were identified with the help of standard reference books (Grimmett *et al.* 2011) [11]. The birds were categorized into various categories following Ganpule (2016) [12], Grimmet *et al.* (2011) [11] and IUCN red data book (2017) [13].

As per Asian waterfowl Census (AWC 2015) a total of 129 avifaunal species was reported in the study area inclusive of terrestrial and wetland birds (Vargiya *et al.* 2015) [8]. However, during present study, about 111 species of birds is recorded in the Mokarsagar wetland complex (Annexure-1) belonging to 42 families. Among the families, the Anatidae (Ducks, Geese) was dominant with 12 species, followed by Ardeidae (Egrets, Herons) with 9 species and Scolopacidae (Waders, Shorebirds) with 8 species (Table:-1). Based on its habitat use, 73 species (66%) belonged to aquatic birds and 38 species (34%) represented terrestrial. Further, 67 species (60%) were resident, 39 species (35%) migratory and 5 species (5%) resident migratory species. Based on the threatened status (IUCN 2017) [13], around 100 species (90%) represented least concern category, 4 species (4%) were vulnerable and 7 species (6%) belonged to Near Threatened (Fig.2, Table-2).

Results

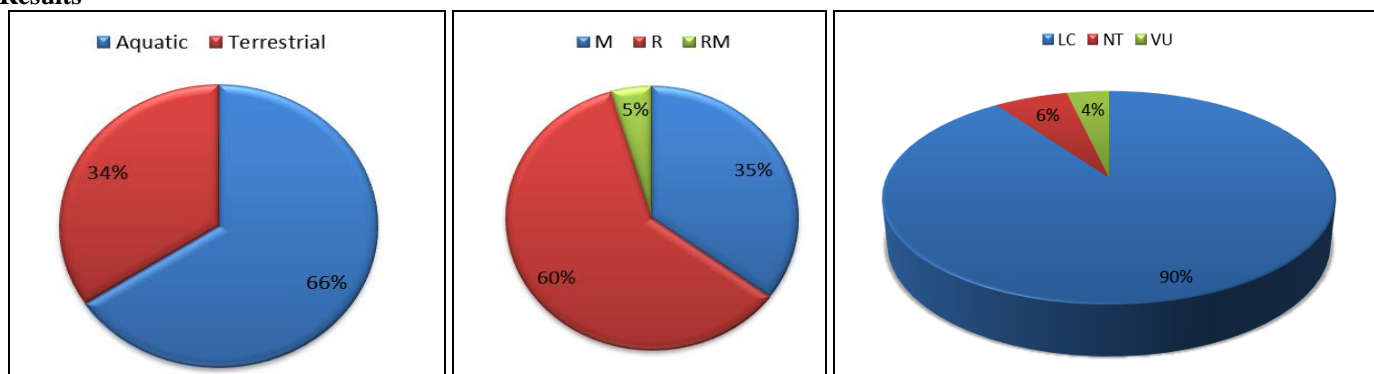


Fig 2: Different categories of Birds from Study area

Table 1: Family wise species richness

Family	No. of Species	Family	No. of Species
Accipitridae	4	Meropidae	2
Alaudidae	1	Motacillidae	3
Alcedinidae	3	Muscicapidae	3
Anatidae	12	Nectariniidae	1
Anhingidae	1	Pandionidae	1
Ardeidae	9	Passeridae	1
Burhinidae	1	Passeriformes	2
Charadriidae	1	Pelecanidae	2
Charadriiformes	2	Phalacrocoracidae	2
Ciconiidae	3	Phasianidae	2
Cisticolidae	1	Phoenicopteridae	2
Columbidae	7	Ploceidae	1
Corvidae	2	Psittaculidae	1
Cuculidae	1	Pycnonotidae	1
Dicruridae	1	Rallidae	3
Estrildidae	1	Ramphastidae	1
Gruidae	2	Recurvirostridae	2
Hirundinidae	2	Scolopacidae	8
Jacaniidae	1	Sturnidae	5
Laridae	7	Sylviidae	1
Leiothrichidae	1	Threskiornithidae	4

During the survey, one carcass of Dalmatian Pelican, vulnerable species (IUCN 2017) was reported at Mokasagar wetland (Fig.4). Observation at the Kuchhadi-Javar wetland indicates flocks of painted stork (NT) flying very close over the electric power line (Fig.4). Likewise, Caspian gull is found soaring around the electric power line grid at Subhashnagar (Fig.4). During the study interaction with the villagers indicates higher mortality of Pelicans, Flamingoes, Raptors, Stork, Ibis and Cranes due to collisions. Further, during the migration of Demoiselle cranes Baradasdagar dam there is movement of thousands across the region and the wind farm present in the close vicinity enhance the risk of collision and bird hit (Fig.4). Carcasses are scavenged by predators like Golden jackals (*Canis aureus*), Indian foxes (*Vulpes bengalensis*) and Jungle Cat (*Felis chaus*) found in good number in the region and could be one of the reasons for reporting low carcass.

Table 2: List of IUCN Threatened Species of Study area

Sr. No	Species Name	IUCN Status	Migration Status
1	Dalmatian Pelican	VU	M
2	Greater Spotted Eagle	VU	M
3	Common Pochard	VU	M
4	Woolly necked stork	VU	R
5	Lesser Flamingo	NT	RM
6	Painted Stork	NT	R
7	Black headed Ibis	NT	R
8	Oriental Darter	NT	R
9	Black-tailed Godwit	NT	M
10	Eurasian curlew	NT	M
11	Indian River tern	NT	R

NT = Near Threatened; R = Resident; M= Migratory; RM = ?

Discussion

Wind power project along the Porbandar coastline is located in an environmentally high sensitive area and one of the important bird area (IBA) of state. The wetlands in the region attract important birds and also lie in the Central Asian

migratory flyway thereby gaining high ecological significance. There are studies revealing that migratory birds avoid the wind turbine sites (Villegas-Patracca, 2012) [14], but in the present study around 44 migratory birds was reported. Waterfowls, raptors, other large water birds and perching birds are at higher risk for colliding with power lines and windmills. The physiological and behavioral characteristics of these birds play an important role to determine the extent of damage.

There are few recommendations that need to be implemented: (1) Turbines and power lines must be at a minimum distance of 1 km from the wetland boundary (2) New power or proposed lines should be in clustering (Fig.3) to reduce the collisions and electrocutions of birds. (3) At high collision area, some marker device and Birds flight diverter (Fig.4) on power line could be helpful to improve the visibilities. The devises should be on each 10-15 m distance on power line (4) At high risk zone, Power lines should be insulated, when insulation is not possible, Perch guard should be installed to reduce the impact of electrocutions, particular in Raptors, Ibis, Pea fowls and Storks. (5) Seasonal bird counts and regular avifaunal mortality recordings should be done on a long-term basis to understand the impact and changes in the wind farm bird assemblages and their response to the wind farm operations.

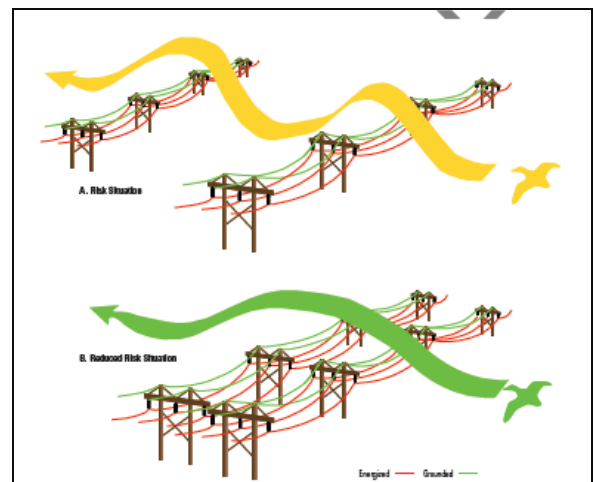
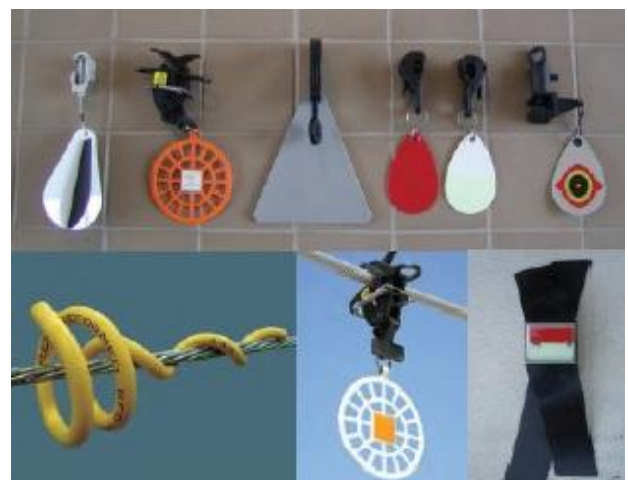


Fig 3: Clustering of Power lines



Source: (APLIC- 2012) [15]

Fig 4: Marker devises and Birds flight diverters

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Fig 4: Clock wise (A) Carcass of Dalmatian Pelican IUCN Vulnerable (VU) Species (B) Caspian Gull Flying near to Electric line pole (C) Flock of Demoiselle Cranes is coming through Windmills (D) Osprey perching on electric line pole at high risk of collision (E) Demoiselle crane at risk of collision with Distribution lines (F) Painted Stork (NT) flying over the Electric line

Annexure I: Check-list of bird species recorded at study areas.

Sr. No	Common Name	Scientific Name	A/T	Migratory Status	IUCN status (2016)
Accipitridae					
1	Shikra	<i>Accipiter badius</i>	T	R	LC
2	Western Marsh Harrier	<i>Circus aeruginosus</i>	A	M	LC
3	Greater Spotted Eagle	<i>Clanga clanga</i>	T	M	VU
4	Black winged kite	<i>Elanus caeruleus</i>	T	R	LC
Alaudidae					
5	Ashy Crowned sparrow-lark	<i>Eremopterix griseus</i>	T	R	LC
Alcedinidae					
6	Common kingfisher	<i>Alcedo atthis</i>	A	R	LC
7	Pied Kingfisher	<i>Ceryle rudis</i>	A	R	LC
8	White throated kingfisher	<i>Halcyon smyrnensis</i>	A	R	LC
Anatidae					
9	Northern pintail	<i>Anas acuta</i>	A	M	LC

10	Common Teal	<i>Anas crecca</i>	A	M	LC
11	Mallard	<i>Anas platyrhynchos</i>	A	M	LC
12	Indian Spot billed duck	<i>Anas poecilorhyncha</i>	A	R	LC
13	Common Pochard	<i>Aythya ferina</i>	A	M	VU
14	Lesser whistling duck	<i>Dendrocygna javanica</i>	A	R	LC
15	Eurasian Wigeon	<i>Mareca penelope</i>	A	M	LC
16	Gadwall	<i>Mareca strepera</i>	A	M	LC
17	Cotton Teal	<i>Nettapus coromandelianus</i>	A	R	LC
18	Comb duck	<i>Sarkidiornis melanotos</i>	A	R	LC
19	Northern Shoveller	<i>Spatula clypeata</i>	A	M	LC
20	Rudy Shelduck	<i>Tadorna ferruginea</i>	A	M	LC
Anhingidae					
21	Oriental Darter	<i>Anhingidae melanogaster</i>	A	R	NT
Ardeidae					
22	Great white egret	<i>Ardea alba</i>	A	R	LC
23	Grey heron	<i>Ardea cinerea</i>	A	R	LC
24	Purple Heron	<i>Ardea purpurea</i>	A	R	LC
25	Indian Pond heron	<i>Ardeola grayii</i>	A	R	LC
26	Cattle egret	<i>Bubulcus ibis</i>	A	R	LC
27	Green backed heron	<i>Butorides striatus</i>	A	R	LC
28	Little egret	<i>Egretta garzetta</i>	A	R	LC
29	Western reef egret	<i>Egretta gularis</i>	T	R	LC
30	Intermediate egret	<i>Ardea intermedia</i>	A	R	LC
Burhinidae					
31	Eurasian thicknee	<i>Burhinus oedicephalus</i>	A	R	LC
Charadriidae					
32	Pacific Golden Plover	<i>Pluvialis fulva</i>	A	M	LC
Charadriiformes					
33	Red-wattled lapwing	<i>Vanellus indicus</i>	A	R	LC
34	Yellow-wattled lapwing	<i>Vanellus malabaricus</i>	A	R	LC
Ciconiidae					
35	Asian open bill	<i>Anastomus oscitans</i>	A	R	LC
36	Woolly necked stork	<i>Ciconia episcopus</i>	A	R	VU
37	Painted stork	<i>Mycteria leucocephala</i>	A	R	NT
Cisticolidae					
38	Common Tailor bird	<i>Orthotomus sutorius</i>	T	R	LC
Columbidae					
39	Kentish plover	<i>Charadrius alexandrinus</i>	A	R	LC
40	Little ringed plover	<i>Charadrius dubius</i>	A	M	LC
41	Greater Sand plover	<i>Charadrius leschenaultii</i>	A	M	LC
42	Rock Pigeon	<i>Columba livia</i>	T	R	LC
43	Eurasian collared Dove	<i>Streptopelia decaocto</i>	T	R	LC
44	Laughing Dove	<i>Streptopelia senegalensis</i>	T	R	LC
45	Red Collared Dove	<i>Streptopelia tranquebarica</i>	T	R	LC
Corvidae					
46	Large billed crow	<i>Corvus macrorhynchos</i>	T	R	LC
47	House crow	<i>Corvus splendens</i>	T	R	LC
Cuculidae					
48	Asian Koel	<i>Eudynamis scolopacea</i>	A	R	LC
Dicruridae					
49	Black Drongo	<i>Dicrurus macrocercus</i>	T	R	LC
Estrildidae					
50	Indian Silver bill	<i>Euodice malabarica</i>	T	R	LC
Gruidae					
51	Demoiselle crane	<i>Grus virgo</i>	A	M	LC
52	Common crane	<i>Grus grus</i>	A	M	LC
Hirundinidae					
53	Red rumped swallow	<i>Cecropis daurica</i>	A	M	LC
54	Barn swallow	<i>Hirundo rustica</i>	A	M	LC
Jacanidae					
55	Bronze winged Jacana	<i>Metopidius indicus</i>	A	R	LC
Laridae					
56	Whiskered tern	<i>Chlidonias hybrida</i>	A	M	LC
57	Gull-billed tern	<i>Gelochelidon nilotica</i>	A	M	LC
58	Caspian tern	<i>Hydroprogne caspia</i>	A	RM	LC
59	Black-headed Gull	<i>Chroicocephalus ridibundus</i>	A	M	LC
60	Brown headed gull	<i>Chroicocephalus brunnicephalus</i>	A	M	LC

61	Slender-billed Gull	<i>Chroicocephalus genei</i>	A	M	LC
62	Indian River tern	<i>Sterna aurantia</i>	A	R	NT
Leiothrichidae					
63	Jungle babbler	<i>Turdoides striata</i>	T	R	LC
Meropidae					
64	Asian green bee-eater	<i>Merops orientalis</i>	T	R	LC
65	Blue-tailed Bee-eater	<i>Merops philippinus</i>	A	R	LC
Motacillidae					
66	Tawny Pipit	<i>Anthus campestris</i>	T	M	LC
67	Paddy field pipit	<i>Anthus rufulus</i>	T	R	LC
68	Long billed pipit	<i>Anthus similis</i>	T	M	LC
Muscicapidae					
69	Indian Robin	<i>Copsychus fulicatus</i>	T	R	LC
70	Oriental magpie robin	<i>Copsychus saularis</i>	T	R	LC
71	Siberian Stonechat	<i>Saxicola maurus</i>	T	M	LC
Nectariniidae					
72	Purple Sunbird	<i>Cinnyris asiaticus</i>	T	R	LC
Pandionidae					
73	Osprey	<i>Pandion haliaetus</i>	A	M	LC
Passeridae					
74	House sparrow	<i>Passer domesticus</i>	T	R	LC
Passeriformes					
75	Common babbler	<i>Argya caudata</i>	T	R	LC
76	Large Grey Babbler	<i>Argya malcolmi</i>	T	R	LC
Pelecanidae					
77	Dalmatian pelican	<i>Pelecanus crispus</i>	A	M	VU
78	Great White Pelicans	<i>Pelecanus onocrotalus</i>	A	RM	LC
Phalacrocoracidae					
79	Little cormorant	<i>Microcarbo niger</i>	A	R	LC
80	Great Cormorant	<i>Palacrocorax carbo</i>	A	R	LC
Phasianidae					
81	Grey francolin	<i>Francolinus pondicerianus</i>	T	R	LC
82	Indian peafowl	<i>Pavo cristatus</i>	T	R	LC
Phoenicopteridae					
83	Lesser Flamingo	<i>Phoeniconaias minor</i>	A	RM	NT
84	Greater Flamingo	<i>Phoenicopterus roseus</i>	A	R	LC
Ploceidae					
85	Baya weaver	<i>Ploceus philippinus</i>	T	R	LC
Psittaculidae					
86	Rose-ringed parakeet	<i>Psittacula krameri</i>	T	R	LC
Pycnonotidae					
87	Red-vented bulbul	<i>Pycnonotus cafer</i>	T	R	LC
Rallidae					
88	Common coot	<i>Fulica atra</i>	A	R	LC
89	Common moorhen	<i>Gallinula chloropus</i>	A	R	LC
90	Purple Swampphen	<i>Porphyrio porphyrio</i>	A	R	LC
Ramphastidae					
91	Coppersmith barbet	<i>Psilopogon haemacephalus</i>	T	R	LC
Recurvirostridae					
92	Black winged stilt	<i>Himantopus himantopus</i>	A	R	LC
93	Pied avocet	<i>Recurvirostra avosetta</i>	A	M	LC
Scolopacidae					
94	Common Sandpiper	<i>Actitis hypoleucos</i>	A	M	LC
95	Little Stint	<i>Calidris minuta</i>	A	M	LC
96	Ruff	<i>Calidris pugnax</i>	A	M	LC
97	Common Snipe	<i>Gallinago gallinago</i>	A	M	LC
98	Black tailed Godwit	<i>Limosa limosa</i>	A	M	NT
99	Eurasian curlew	<i>Numenius arquata</i>	A	M	NT
100	Wood Sandpiper	<i>Tringa glareola</i>	A	M	LC
101	Common Redshank	<i>Tringa totanus</i>	A	M	LC
Sturnidae					
102	Bank Myna	<i>Acridotheres ginginianus</i>	T	R	LC
103	Common Myna	<i>Acridotheres tristis</i>	T	R	LC
104	Rosy Starling	<i>Pastor roseus</i>	T	M	LC
105	Brahminy starling	<i>Sturnia pagodarum</i>	T	R	LC
106	Common starling	<i>Sturnus vulgaris</i>	T	M	LC
Sylviidae					

107	Lesser white throat	<i>Sylvia curruca</i>	T	M	LC
Threskiornithidae					
108	Eurasian Spoonbill	<i>Platalea leucorodia</i>	A	RM	LC
109	Glossy ibis	<i>Plegadis falcinellus</i>	A	RM	LC
110	Indian Black Ibis	<i>Pseudibis papillosa</i>	A	R	LC
111	Black headed ibis	<i>Threskiornis melanocephalus</i>	A	R	NT

A=Aquatic; T= Terrestrial; M=Migratory; RM= Resident & Migratory; R= Resident; NT= Near threatened ; LC= least concern; VU= vulnerable

References

- Gipe P. Wind energy comes of age. John Wiley and Sons, Inc. NY. 1995.
- Redlinger RY, Andersen PD, Morthorst PE. Wind Energy in the 21st Century: Economics, Policy, Technology and the Changing Electricity Industry. Palgrave Publishers, Basingstoke. 2002.
- Osborn RG, Higgins KF, Usgaard RE, Dieter CD, Neiger RG. Bird mortality associated with wind turbines at the Buffalo Ridge Wind Resource Area, Minnesota. Am. Midl. Nat. 2000; 143:41-52.
- Askins RA, Folsom CM, O'Keefe, Hardy MC. Effects of Vegetations, corridor width and regional land use on early successional birds on powerline corridors. PLoS ONE. 2012; 7(2):e31520. Doi: 10.1371/journal.pone.0031520.
- Drewitt AL, Langston RHW. Assessing the impacts of wind farms on birds. Ibis. 2006; 148:29-42.
- Lekuona JM, Ursua C. Avian mortality in wind power plants of Navarra (Northern Spain). In: Proceedings of Birds and Wind Farms, M. de Lucas, G.F.E. Janss and M. Ferrer (Eds.), Quercus, Madrid. 2007.
- GAO. US Government Accountability Office, Wind power: Impacts on wildlife and government responsibilities for regulating development and protecting wildlife. US Government Accountability Office, Report GAO-05-906, Washington, DC. 2005.
- Vargiya DV. Asian Waterbird Census (AWC) Porbandar, Shree Sahajanand Swami District Community Science Centre, Gujarat, India. 2015.
- Bibby CJ, Burgess ND, Hill DA, Mustoe SH. Bird Census Techniques, 2nd ed. Academic Press, London, 2000.
- Gaston AJ. Estimating bird population. Journal of the Bombay Natural History Society. 1975; 72:271-283.
- Grimmett R, Inskipp C, Inskipp T. Birds of the Indian subcontinent. 2nd ed. New Delhi: Oxford University Press, 2011.
- Ganpule P. The Birds of Gujarat-Status and Distribution. Flamingo. 2016; 12(4):1-40.
- <http://www.iucnredlist.org>
- Villegas-Patracca R, Macgregor-Fors I, Ortiz-Martinez T, Perez-Sanchez C, Herrera-Alsina L, Munoz-Robles C. Bird-Community Shifts in Relation to Wind Farms: A Case Study Comparing a Wind Farm, Croplands, and Secondary Forests in Southern Mexico. The Condor. 2012; 114:711-719.
- Avian Power Line Interaction Committee (APLIC). Reducing Avian Collisions with Power Lines: The State of the Art, Edison Electric Institute and APLIC. Washington, D.C. 2012.