Asian Journal of Conservation Biology, December 2020. Vol. 9 No. 2, pp. 352-358 AJCB: SC0051
ISSN 2278-7666 ©TCRP Foundation 2020

Short Communication

Breeding Ecology of River Tern (*Sterna aurantia*) at Ujjani-Bhigwan Reservoir Bird Sanctuary near Pune-Solapur Highway, India

Shivaji Chavan[1*] and Arvind Kumbhar[2]

[1]*Department of Zoology, School of Life Sciences, Swami Ramanand Teerth Marathwada University, Nanded - 431606, Maharashtra, India.*
[2]*Department of Zoology, Shankarrao Mohite Mahavidhyalaya, Akluj, District Solapur, M. S., India*

(Received: May 28, 2020; Revised: July 27, 2020; Accepted: October 16, 2020)

ABSTRACT

The Charadriiformes species are land nesters for laying during breeding season. Ujjani-Bhigwan Reservoir Bird Sanctuary is recently declared as an established IBA area that support 230 local, migratory visitors and transit avifauna since year 1980. River Tern (*Sterna aurantia*) use isolated islands in the reservoir and peripheral scrubs land to construct depression type of nests for laying during hot summer of April-May months every year. Reproductive indices of River Tern that include nest density (n=870), nest site selection, clutch size and anthropogenic disturbances recorded from 14 nesting grounds around the reservoir. Variation in annual rainfall in catchment area of the reservoir, use of water for irrigation and drinking water source were major deciding factors to decrease water level in the reservoir. Decreased water level results in to exposure of islands that favors nesting but affect negatively on breeding activity due to easy access for the vehicle movements for sand dredging and transportation across the nesting area. Trampling by grazing cattle and local anthropogenic activities caused considerable damage of eggs under incubation, nestlings and chicks of River Tern at nesting places around the reservoir. Nevertheless the URBS has been established as IBA for the breeding of this wader.

Key Words: Birds, Ground-nesting, Ujjani-Bhigwan, River-Tern, Maharashtra.

INTRODUCTION

River Tern (*Sterna aurantia*) the important wader bird recently reached to Near Threatened (NT) category according to IUCN (Collar *et. al,* 1994; del Hoyo *et. al,* 1996) due to rapid decline in its population. Global population of this species estimated 50,000 to 1,00,000 individuals whereas 50,000 individuals estimated in India. In the major parts of its distributional range across Southern and South-East Asia it is undergoing moderately rapid reduction trend of population (Bird Life International, 2020 (a); Delaney and Scott, 2006). Already it is declared very rare in Thailand (del Hoyo *et. al,* 1996). Similar decline trend has been reported in Laos and Cambodia (Thewlis et. al, 1998). It is rare and very local in Nepal to drastic reduction in population up to 20 individuals estimate in year 2016 (Inskipp *et al,* 2016). It is uncommon along river Dayingjiang in Yunnan (Bird Life Int., 2020 (b)). Due to support from reservoir ecosystem in India the population of River Tern got assured areas on seasonally exposed island and islets for breeding. In Andhra Pradesh State of India it has increasing population trend since 2000 to 2010. The demography, feeding and breeding ecology of Plovers including River Tern in Asia is not known in this context the present study was planned as its main goal. Out of 155 species of Plovers in the world 03 species already extinct and others are facing serious threats for their existence (del Hoyo *et al.,* 2020). It has been found that demography of 70 % Plover species is completely unknown (Bird Life Int., 2020 (b)). Three important Bird Areas (IBA) are reported (Bird Life Int. 2020) for the River Tern where it is under Near Threatened (NT) category that include Ujjani-Bhigwan Reservoir Bird Sanctuary (URBS) in Maharashtra State, India and other IBA are Gossbara (Moksar) Wetland complex and Indus Dolphin Reservoir, Kandhkot wetland in Pakistan (del Hoyo *et al,* 2020). Major threats for decreased population trend of this species mainly include human intrusion and disturbance in breeding habitat. Invasion of species like domestic buffalo (*Bubulus bubalis*), stray dogs, wild rats, common crow (*Carvus splendence*) and Raccoons also cause brood destruction, reduce reproductive success and brood mortality. In its main distributional range of 97.30 Lakh km^2 in India, Iran, Afghanistan, Myanmar and Nepal, intense land use for agriculture, pesticide effects, destruction of breeding ground, food scarcity and hunting are important causes for degradation of breeding habitats of River Tern (Birdlife Int., 2020). This Tern species need dire care for its breeding grounds in its established IBA's to save its decreasing population trend. During breeding and non-breeding season always it prefers to live in small to large colonies containing10-300 nests (Sathiyaselvum and Blachandran, 2007). Largest breeding colonies of River Tern have been recorded at Chilka lake in Orrisa, India (Sathiyaselvum and Blachandran, 2007). Narwade and Pharatade (2013) reported a regular breeding colony of River Tern on top of a semi-submerged historical palace (Inamdar Wada) ruins near village Kalsi of Ujjani reservoir at Northern Banks of the Reservoir; this is the only report on reproductive aspects of this species. Dam constructions across the rivers cause flooding and overexposure of breeding areas promisingly alter the breeding seasons of River Terns is well known but importance of Dam could also be planned for the betterment of birds along with human being need to focus for the conservation of avian diversity. The species prefer mostly inaccessible areas from human interfere for breeding but most of the identified area in present study were not matching with this natural and ideal needs.

Therefore present study was aimed to determine some important breeding indices includes the nest

*Corresponding Author's E-mail: dr_spchavan@rediffmail.com

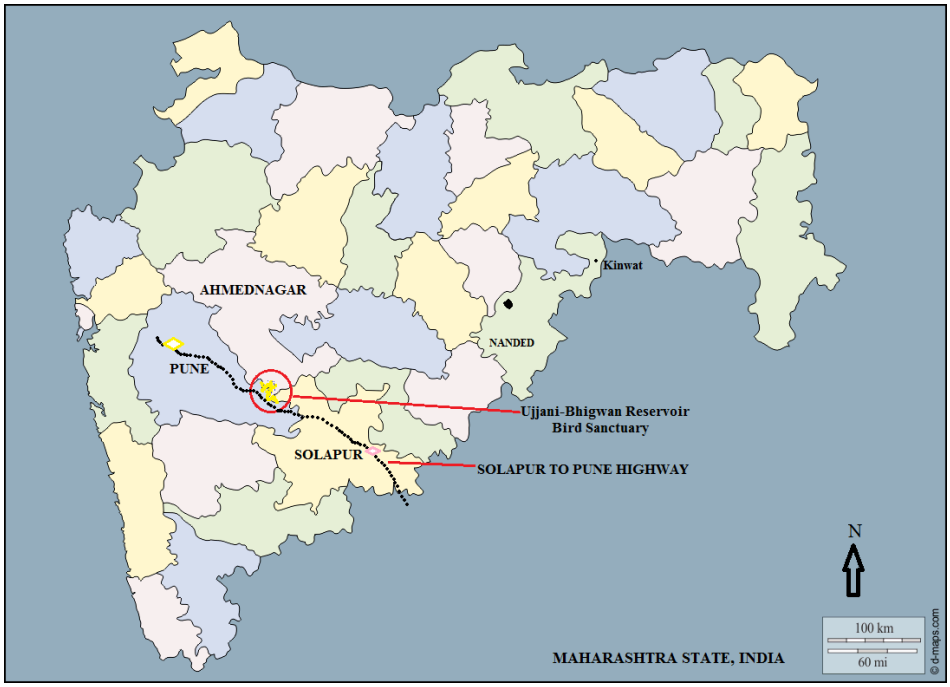

Figure 1. Map of Maharashtra state, India showing the location of study area.

density, hatching success and fledged chicks, egg destruction and anthropogenic activity impacts on this wader species to suggest the need of special and intentional conservational efforts in this established IBA for this species.

MATERIALS AND METHODS

The River Tern is ground nesting wader. It is colonial breeder. The study was conducted in IBA identified for this species (Bird Life International, 2020) at Ujjani-Bhigwan Reservoir Bird Sanctuary (URBS) near Solapur -Pune highway in Maharashtra State of India. Satellite imagery of this reservoir show dragon shape forming serpentine turns and bends in the water body (Figure 1). During year 2017-18 in the month of May nesting areas of River Tern was identified from the base of the reservoir backwater to embankment of reservoir on both the banks. Access to the study area was easy due to its location near Solapur to Pune highway and interior area with village road network that facilitated easy reach to the nesting sites. Therefore it was easy to reach the identified nesting grounds by walk and motorcycle. Non-mechanized circular, bowl shaped, locally made fishing rafts were used to reach the island-plateau interior in to the reservoir. Every nesting site was visited before and after egg laying to note site selection for nesting, nest demography and mixed species nesting if any. Line transects and point count method was used to survey the nests. Before egg laying each nest was visited for morphometric study. Nest materials used were collected as samples for further study. The empty shells of Mollusks from the nest were identified (Subba Rao, 1986; Editor-Director ZSI, 2002). Clutch size was measured for number of eggs/nest at sample sites in entire study area. Mixed nesting of other wader species was also noted with nests of River Tern. Nesting success, breeding success, fledging success, hatching success, mortality, predation and effect of human disturbance were noted and analyzed statistically. Fish samples were collected from the fishermen of this region and identified to species level (Frose and Pauly, 2020).

Study area

To determine the breeding ecology of River Tern (*Sterna aurantia*) Ujjani-Bhigwan reservoir Bird Sanctuary (URBS) was selected. The URBS consists of a earth fill gravity Dam with concrete sluice gates near village Ujjani and having storage capacity 3,140, 000, 000 M^3 in 2, 550,000 acres water spread area. The Dam is constructed on River Bhīma one of the main tributary of River Krishna forming Krishna river basin in western Maharashtra. Catchment area for this reservoir is eastern parts of Western Ghats mainly including parts of district Pune and Ahmednagar of Maharashtra State. It is located on the match point of geographical borders of district Pune, Ahmednagar and Solapur of M. S. The reservoir was constructed during year 1969 to 1980 under multipurpose needs of water for irrigation, drinking, hydroelectric and industrial use (NRLD, 2020). Satellite imagery of this reservoir is serpentine in form (Figure 1). Nearest towns to the study area are Indapur, Bhigwan and Solapur. It is 105 km. east of Pune city. There are 50 villages all along the southern and northern banks of this reservoir of that area 14 villages were selected as sample sites for this study. All these villages have access by road to the Solapur-Pune highway. The land around the URBS remains under cultivation for crops like sugarcane, pigeon pea, gram, peanuts, wheat, Jowar and several horticulture plantations throughout year. Latitude and longitude details of 14 nesting sites of River Tern at the reservoir were noted (Table 1). The months of March, April and May are hot summer in the URBS area with average environmental temperature 38-40 ^{0} C.

RESULTS

In the present study it was observed that the River Tern prefers isolated areas away from human interfere especially sand dunes in river beds, temporary islands or exposed plateau developed in the reservoir due to decreased water level during summer months (March to May). Total number of nests of River Tern at 14

identified nesting sites was 870 having total 3,206 eggs. This species is dependent on fishes and Mollusks in the reservoir for own need of food, to feed the chicks and to use the shells as nest materials. Maximum nests were 322 at Kedgaon village. To south coast of the reservoir 257 nests were found near village Shah (20 km. from Indapur town near Solapur-Pune Highway). In 74.6 % nests clutch size was 4/nest. The most ideal nesting site preferred by the River Tern was an island in the reservoir near village Shah. In the month of May an isolated area of approx. 500 sq. ft. from mainland get exposed in the reservoir near village Shah due to release of water from the reservoir in to downstream area for irrigation to agriculture. Similarly the demand of drinking water for cities around the reservoir increase that also causes exposure of island. The island formed was 400-500 meters away from village Shah, protected from all around by reservoir water hence remain cut-off from the village. But when the reservoir water level further drop down then a approach road get developed between island and village Shah that cause worst situation for the nest destruction at the island. The villagers especially children and cattle grazers reach the island using this road to cause disturbance in nesting and nest destruction. Once the way develop to reach island then the sand mining starts and remain as established routine activity till monsoon. The boats start to deposit sand on the island and carried from there to nearby cities using tractors and trucks by road via Tern Breeding Island to village Shah. Sand dredging and transportation process cause massacre of laid eggs, chicks and entire nest. When an interfere by vehicle or human occurs as intrusion on the island, all the Terns fly randomly by kiosk sound and display false bombing dive attack on the

Table 1. Regular nesting sites and nest phenology of River Tern near villages along the coasts of Ujjani Reservoir Bird Sanctuary.

Nesting sites	Latitude and Longitude	No. of Nests	No. of Eggs	Clutch Size/Nest site 02	03	04
Southern Coast of the Reservoir						
****Shah**	18^0 06' 41" N, 75^0 06' 46" E	257	951	24	159	768
Sardewadi	18^0 07' 02" N, 75^0 05' 22" E	22	80	04	12	64
Sugaon	18^0 92' 02" N, 75^0 05' 22" E	19	70	02	12	56
Kalthan	18^0 10' 57" N, 75^0 01' 13" E	14	51	02	09	40
Gagargaon	18^0 10' 30" N, 75^0 00' 15" E	08	30	00	06	24
Northern Coast of the Reservoir						
Jinti	18^0 08' 53" N, 74^0 51' 15" E	04	15	00	03	12
Katraj	18^0 17' 40" N, 74^0 50' 28" E	09	34	00	06	28
Takli	18^0 15' 46" N, 74^0 51' 18" E	16	59	02	09	48
Pomalwadi (Rly.)	18^0 16' 07" N, 74^0 56' 33" E	28	102	06	12	84
Washimbe (Rly.)	18^0 15' 04" N, 75^0 01' 40" E	21	62	02	03	57
Umrad	18^0 18' 38" N, 75^0 03' 30" E	34	130	04	06	120
***Kedgaon**	18^0 15' 40" N, 75^0 03' 33" E	322	1200	28	180	992
***Chikhalthan**	18^0 12' 08" N, 75^0 01' 47" E	72	272	10	18	244
Shelgaon	18^0 10' 06" N, 75^0 00' 40" E	44	150	08	54	88
Total breeding sites (n= 14)		870	3206	92	489	2625

(* Marked nesting sites are well established and without much disturbance in breeding process,
** Marked nesting site was highly disturbed due anthropogenic activities and predation)

Table 2. Factors affecting % destruction of eggs at the nesting sites (n=14)

Cause of destruction	% Eggs destroyed from total Laid eggs (n=3206)	% Eggs destroyed from total destroyed eggs (n= 229)
Predation by stray Dogs	1.9	26.0
Vehicle Movements	3.3	47.5
Trampling by Cattle	1.4	20.9
Cricket play by children and Motorcycle racing	0.37	5.2

intruders to threaten. It was display of an opposing behavior. The brood destruction at the island near village Shah was 10.5 % (predation by stray dogs), 17.0 % (vehicles), 5.0 % (Cattle trampling), 4.6 % (Cricket play and motorcycle racing by villagers). Total destruction of laid eggs at this site due to human interfere was 26.6 %. Another prominent nest site was at village Kedgaon, 322 active nests with 1200 eggs (77.0 % clutch size 4); total destruction was 23.9 % by human interfere. The % destruction by vehicles was 75.3 % whereas 20.7 % egg destruction at this nesting site was by stray dogs. Other nesting sites were near village Pomalwadi and Washimbe (Table 1), where the abandoned narrow-gauge railway track of British period get exposed due to low water level and remain free from any intrusion either of human or any domestic animals hence the nest destruction at these sites was zero. Average of clutch size at 14 nesting sites was 5.2 % (clutch 2), 18.8 % (clutch 3), 75.7 % (clutch 4). Total number of eggs destroyed was 229 from 3206 laid eggs i.e. egg destruction percentage was 7.14. Highest destruction was 47.5 due to vehicles, 26 % by dog predation out of total 229 egg destruction. From total egg destruction 20.9 % was by cattle trampling and 5.2 % due to cricket play by children from nearby villages. Out of 3206 laid eggs the cause of egg destruction was 60 eggs by dog predation (1.8 %), 109 by vehicle (3.3 %), 48 by cattle trampling (1.49 %), 12 by local children cricket play (0.37 %). All these are human activity oriented destructions. It can be summarized that destruction of eggs at nests during incubation and hatching process was highest due to vehicle movement for sand mining followed by predation by dogs. At places like village Katraj, Jinti and Kedgaon temporary pastures are formed where cattle grazing especially domestic buffalo (*Bubulus bubalis*) were common, that results in trampling of laid eggs and nest destruction. Indirect causes of egg destruction were fishing, tourist activities (Narwade and Phartade, 2013) and sand mining. The reservoir sanctuary is transit resting ground for several species of ducks in South-East Asia flyway and the Lesser flamingo visit regularly in thousands to the shallow coastal water area (Karikar *et al,* 2017). Several amateur photographers and nature lovers visit this sanctuary those also cause indirect disturbance in breeding process of wader species including River Tern. Fishing by drag-net is a regular activity at this reservoir sanctuary. During fishing the operation of fishing boats, fishermen movements for net dragging disturb the breeding activity and destroy the nests, eggs and chicks of River Tern and other waders. These were regular activities in the reservoir area and one of the confirmed causes observed but not focused for exact qualification for brood destruction (Table 2).

Reproduction Indices

The reproductive indices of River Tern calculated (Kazantzidis et. al, 1997; Asokan et. al, 2010) from the study area (URBS) mainly include Nesting success, Hatching success, Fledging success and Breeding success (Table 3, Figure 2). These calculations were based on the basic data that include total number of habitats observed in URBS near various villages along the coast of reservoir (N = 14), total number of active nests identified and monitored (N = 870) and total number of eggs found in the nests (N = 3206). The mean nesting success was 3.62 indicating the reproductive potential of the River Tern in the study area was fairly close to clutch size 04/nest with SD = 0.21 and Standard Error of Mean (SEM) = 0.05. The frequency distribution of nest success indicates highest nest success value 3.82 at sampling station near village Umrad and lowest 2.95 at village Washimbe. The mean hatching success was highest at 99.7 (SD = 5.44 and SEM = 1.45); highest value was 99.08 near sample station Kedgaon whereas lowest 65.4 near village Shah having highest anthropogenic disturbance (Figure 2). The mean value of fledging success was 90.6 (SD = 5.44, SEM = 1.45) indicate the sanctuary is well established to support the River Tern for high fledging success. Breeding success of this Tern species was having mean value 3.02 (SD = 0.42, SEM = 0.11), the highest value was 3.69 at breeding site near village Kedgaon reflects one of the best breeding ground of River Tern in the URBS vast area whereas lowest breeding success was 2.40 near village Washimbe which also correlate with low nesting success. Overall observations on the reproductive indices of River Tern at this sanctuary indicates good results that favor nesting, hatching of laid eggs, fledging success and breeding success. It is an indication of URBS is one of the established IBA for River Tern *Sterna aurantia.* The nesting sites were very active for the movement of River Tern and nests were continuously occupied for incubation by either of parents hence we were unable to weigh the eggs and measure the length weight meristics. This species was more aggressive to attack on intruders near the nest that we experienced. Not to disturb this natural process and habitat was our sincere thought behind leaving to measure the parameters related to eggs of this species.

Nest site selection and nest material

At micro-niche level River Tern select the nesting sites near murrain area where the stones remain fixed in ground and half exposed or free. Already existed shallow depression in ground was selected or depression (Plate 1a) was prepared by scratching the ground (Plate 1b). The nest depression was 15-25 cm. in circumference and 3-8 cm. in depth. The depression was loosely filled with empty and intact shells of locally available Gastropods (Waghmare *et al.*, 2012) *Bellamya dissimilis, Bellamya bengalensis, Bellamya eburnean, Taberia granifera, Thira scabra, Taberia lineate Gabia orcula, Pila globosa, Melunoid tuberculata* and shell pieces of bivalve Mollusk species *Lymarea acuminate, Lymarea luteola, Parreyysia corugata, Corbicula pensularis, Corbicula striatella, Lamillidens marginalis, Lamillidens correns.* Comparatively numbers of intact shells of Gastropods were more than pieces of bivalve shell (3:1). The shells form a bottom layer in nest depression. The Tern carries shell pieces or entire Bivalve to the nest site from the reservoir. The Mollusk in the shell dies when the shell gets dried due to intense heat of summer then mollusk inside the shell was removed out using beak and used as food. The shell pieces are used for nesting (Plate 1a-c). The broken pieces of bivalve shell were in plenty in the coastal area of reservoir. Other materials in the nest consist of pieces of dry grass, dried weed and wooden twigs of *Acasia vediana* (Vedi Babul) tree (Plate 1b) and dried leaves of unknown aquatic weed . The River Tern selects inaccessible islands and coastlines of reservoir and sand dunes near brackish water for nesting. Most suitable terrain conditions required for the nesting of River Tern are scrubland with rarely spread creepers, surface covered with small to medium murrain, gravel and sand all along the surface. Every year during summer season in the month of May the reservoir water level drops down due

Table 3. Nesting and Reproductive Indices of River Tern in the study area (URBS)

Nesting sites (N = 14)	Nest success %	Breeding success %	Hatching Success %	Fledging success %
Sardewadi	3.6	3.36	92.5	94.8
Shah	3.7	2.42	65.4	87.7
Sugao	3.6	3.26	88.5	92.5
Kalthan	3.64	3.00	82.3	87.5
Gagargaon	3.75	3.12	83.3	92.5
Jinti	3.75	2.50	66.6	83.3
Katraj	3.77	3.00	79.4	92.5
Takli	3.68	3.20	88.1	94.5
Pomalwadi	3.64	3.14	86.2	91.6
Washimbe	2.95	2.40	82.2	87.9
Umrad	3.82	3.14	82.3	87.7
Kedgaon	3.72	3.69	99.0	99.7
Chikalthan	3.77	3.62	95.9	97.3
Shelgaon	3.40	2.54	74.6	79.4
Mean Value	3.62	3.02	83.31	90.6
SD Value	0.21	0.42	9.78	5.44
SEM	0.05	0.11	2.61	1.45

A. B. C.

Plate 1. Nest site selection and nest material of River Tern *Sterna aurantia* at Ujjani Reservoir Bird Sanctuary. (Photo by S.P. Chavan). A. Shallow depression in ground is used for nesting, B. Dried weed and wooden twigs of *Acasia vediana* and dried leaves of unknown aquatic weed are used as nest material, C. The shell pieces used for nesting.

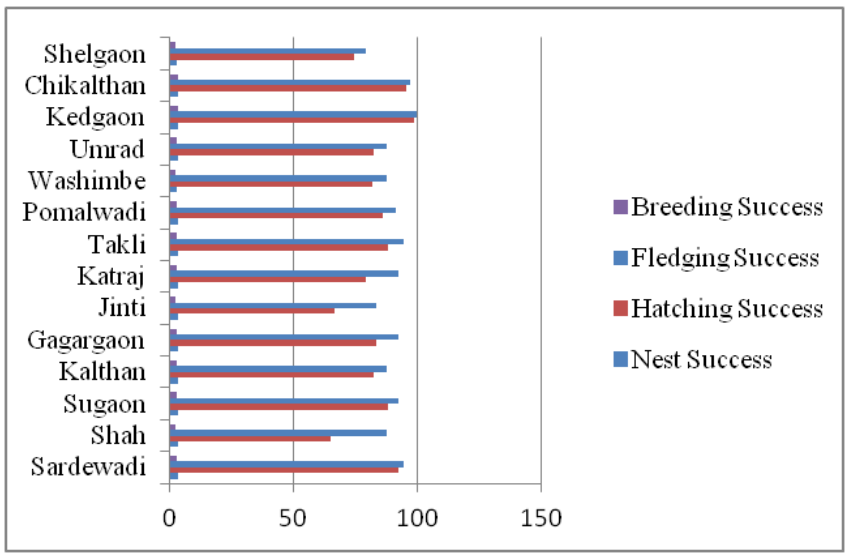

Figure 2. Reproductive indices of River Tern *Sterna aurantia* at Ujjani Reservoir Bird Sanctuary.

to use for irrigation to agriculture that results into development of nesting places for the River Tern in the form of sand dunes, islets and islands with plane surface near all mentioned villages (Table 1). All these habitats facilitated nesting for this Tern species where it shows good success rate of breeding, hatching and fledging (Table 3.). The nesting of other waders observed at the same nesting grounds were of Golden-Ringed Plover (*Charadrius haiticula*) and Black winged Stilt (*Himantopus himantopus*).

DISCUSSION

Degradation of breeding habitat is a serious concern for conservation of plover species due to intensified agriculture, hunting, land use, pesticide effect, destruction of breeding ground and food (Bird Life International, 2020). Narwade and Phartade (2013) have reported occurrence of River Tern breeding colony at URBS near village Kalsi (Indapur Taluka) on an abandoned and semi-submerged historic building named Inamdar Wada and reported nest destruction due to tourism but not reported exact data on it. As compared to confirmed nesting at island near village Shah, Kedgaon and Chikalthan (Table 1., 3.) the nesting at this historic building was minor and annually remain unsure due to effect of tourism. Decrease in water level in the Ujjani reservoir during summer season depend on water input from catchment area that varies based on annual rainfall similarly decrease in water level is also due to irrigation to agriculture. At three major nesting sites (TMNS) near village Shah, Kedgaon and Chikalthan the Mollusk shells as nesting materials were available in plenty (Waghmare *et. al,* 2012) that favors to collect these shells by this Tern easily in less time and efforts. In the present study main focus was on determination of nest demography hence we had not recorded age group variation in breeding population of River Tern (Mundkur, 1992). Weed fishes and larvivorous fishes like *Puntius ticto, Chela phulo* and *Rasboro species* were found in fish catch from this reservoir. The occurrence of these fish species (Frose and Pauly, 2020) were confirmed at TMNS but use of mosquito mesh nets for fishing in the reservoir need to be banned to get assured food for the adult River Tern during chick rearing. At the TMNS major important factors and sources for nesting of this Tern were available but anthropogenic disturbances and egg destruction due to vehicle movement (3.0 % for n= 3206) and 47.5 % for n= 229 (Table 2) was serious issue and one of the alarming breeding ecological threat that need to control as an established IBA for the species in Maharashtra. In the study area at 14 nesting sites 870 nests were identified. At all the sites the nests were perfectly camouflaged with ground texture and color, some of them were highly camouflaged so that only keen and careful observations possible to identified. Ground nests of waders are prevented from predation by camouflage with ground texture, plants and bushes at nesting sites and nest materials (Baily *et al.,* 2015). It is a combine effect of nesting site selection, ground colorations, murrain color and nest material to camouflage the laid eggs to prevent from predation similar to active nests of Yellow Wattled Lapwing (Chavan et. al, 2016); the predators get disguised or unable to trace the nest location. In the present study the camouflaging of nest and laid eggs had not a major issue in brood protection from avian and Mammalian predation (Goes, 2014; Gordon and Maclean, 1972) because all the problems for nest and brood destruction were anthropogenic activities. Chavan et al. (2016) reported in a study on nesting of Yellow Wattled Lapwing *Vanellus malabaricus* nest density 02/15 km^2 and major cause of egg destruction was predation by stray dogs and trampling of eggs by grazing cattle in the nesting area. Chavan *et al*. (2015) reported congregation of River Tern on the patchy sand beds and islets in Godavari river basin of Marathwada region; is indication of long range distribution of this species to search breeding grounds in wide range. Therefore in recent the natural behavior of waders to camouflage the broods has no meaning due to unexpected artificial and unnatural problems created by human beings for this Tern species. Clutch size of charadriids is 04 eggs /nest is the routine trend (Gordon and Maclean, 1972) whereas in present investigation the clutch size was 2-4. At 14 nesting sites 75.6 % nests were having clutch size 4. In one of the study Chavan *et al*. (2015) reported congregation of River Tern on patchy sand beds and small islets in river Godavari which form an important river basin of Marathwada region whereas the present IBA for this species is in western Maharashtra.

CONCLUSION

Ujjani Bhigwan Reservoir Bird Sanctuary (URBS) is one of the IBA for congregation of several local, migratory and transit migratory bird species including River Tern (*Sterna aurantia*). The reservoir on river Bhima get developed to support several birds including River Tern *Sterna aurantia* for its feeding, nesting and breeding needs. In the coastal area and temporarily developed islands in the reservoir 14 different sites were identified where River tern had selected nesting sites for laying and parental care. In all 870 active nests containing 3206 eggs were identified in the breeding grounds. The breeding parameters observed include mean values of nesting success 3.62, hatching success 83.31 %, fledging success 90.6 % and breeding success was 3.02. Destruction of laid eggs were mean value 6.97 % (n = 3206). Anthropogenic activities especially movement of vehicles (47.5 %) followed by egg predation by stray dogs (26.0 %) and trampling by cattle (20.9 %) was major cause for the active nests 870 of total clutch 3206 posing threat to this Tern species. Sample site Kedgaon (Table 3) was proved the best site with comparatively good values to support breeding, hatching and fledging success need to be taken more care during breeding season of River Tern during monsoon. Implication of strict rules for biodiversity conservation under National Biological Diversity Act, 2002 is essential to protect this most favored breeding ground of River Tern in this region which has been established as an IBA for this species since last 50 years. Ban on vehicle movement, sand mining and transport, cattle grazing and cricket play by locals at the Tern breeding sites is highly recommended.

ACKNOWLEDGEMENTS

The Authors are thankful to Zillah Parishad District Solapur to provide guest house accommodation facilities at Katraj, Taluka Karmala, District Solapur during this study. Thanks to the reviewers for important suggestions to strengthen the content on reproductive indices.

REFERENCES

Asokan, S. A., Ali, M. S., Manikannan, R. 2010. Breeding biology of the small bea eater Merops orientalis (Latham, 1801) in Nagpattinam District, Tamil Nadu, India. Journal of Threatened Taxa, 2(4): 797-804.

Bailey, I. E., Muth, F., Morgan, K., Mcddle, S. L., Healy, S. D. 2015. Birds build camouflaged nests. Auk. 132: 11-15.

BirdLife International. 2020 (a). IUCN Red List for Birds. Downloaded from http:// www.birdlife.org on 07/05/2020.

BirdLife International. 2020 (b). Species factsheet: Sterna aurentia. Downloaded from http://www.birdlife.org

Chavan Shivaji, Achegawe Rajesh, Padghane Sharda. 2016. Characters of nesting site, ground nest and eggs of Yellow Wattled Lapwing *Vanellus malabaricus* (Aves: Charadriidae). Int. J. of Zoology Studies, 1 (6): 12-17.

Chavan S. P., Dudhmal D., Hambarde S. and Kulkarni, A. N. 2015. Birds from Godavari Godavari River Basin in Nanded District of Maharashtra State, India: Annotated status and new reports. In. J. Curr. Res. Acad. Rev., 3(4): 328-351.

Collar, N. J., Crossby, M. J. and Statisfield, A. J. 1994. Birds to watch 2: The world list of Threatened Birds. BirdLife Conservation series 4. BirdLife International, Cambridge.

Delany, S., Scott, D. 2006. Waterbird population estimates. Wetland International. Wageningen. The Netherlands.

del Hoyo, J., Elliott, A. and Sargatal, J. 1996. Handbook of the Birds of world, 3: Hoatzin to Auks. Lynx Edicions, Barcelona, Spain.

Editor-Director. 2002. *Published- Director, ZSI, Kolkata.Wetland ecosystem series No. 3, Fauna of Ujani*: i-iv, 1-196.

Frose and Pauly. 2020. www.fishbase.org.

Goes, F. 2014. *The Birds of Combodia*: *an annotated checklist*. Phenom Penh: Fauna & Flora International Cambodia Programme & Royal University of Phenom Penh.

Gordon, L. Maclean.1972. Clutch size and evolution in the Charadrii. The Auk, 89: 299-324.

Inskipp, C., Baral, H. S., Phuyal, S., Bhatt, T. R., Khatiwada, M., Inskipp, T., Khatiwada, A., Guriung S., Singh P. B., Murray, L., Poudyal, L. and Amin, R. 2016. The status of Nepal's Birds; The Natural Red List series. Zoological Society of London.

Karikar Shraddha, Mali Subhash and Kulkarni Prasad. 2017. Status of wetland Birds at Associated lakes of Ujjani Reservoir, Maharashtra, India. International Journal of Applied Environmental Sciences. 12 (5): 909-924.

Karikar Shraddha Prabhakar, Mali Subhash Vithal, Kulkarni Prasad and Aphale Priti. 2019. An assessment of Bird communities across Ujjani and its five satellite wetlands, In Solapur District of Maharashtra, India. Journal of Threatened Taxa. 11 (15): 14989 – 14997. (Doi: 10.11609/jot. 4741. 11.15. 14989-14997).

Kazantzidis, S., Goutner, V., Pyrovetsi, M. and Sinis, A. 1997. Comparative nest site selection and breeding success in two sympatric ardeids, Black-Crowned Night–heron *Nycticorax nycticorax* and Little Egret *Egretta garzetta* in the Axios Delta, Macedonia, Greece. Waterbirds. 20: 505-517.

Mundkur Taej. 1992. Breeding by one year old Indian River tern. Colonial Waterbirds. 15 (1): 144-147.

Narwade Sujit and Phartade kamlakar. 2013. Breeding colony of River Tern on man-made construction in the Deccan plateau, Maharashtra. Mistnet. 14 (4): 17-19.

National Register of large Dams (NRLD). 2011. Maharashtra: Ujjani Dam, Central water commission, Govtt of India, July, 2011.

Sathiyaselvum, P. & Balchandran, S. 2007. A large breeding colony of River Tern *Sterna aurantia* in Chilka Lake Orissa (India). Indian Birds. 3 (2): 65-66.

Subba Rao, N. V. Zoological Survey of India, Calcutta. 1986. 'Handbook Freshwater' Molluscs of India. Mollusc identification- ZSI.

Thewlis, R. M.; Timmins, R. J.; Evans, T. D.; Duckworth, J. W. 1998. The conservation status of Birds of Laos, 8 (supplement). Bird Conservation International.

Ujjani Dam: Theme: Save the Birds- Envirobmental information centre, Govt. of M. S. June, 2011.

Waghmare, P. K., Rao, K. R. and Shaikh, T. A. 2012. A correlation between freshwater Molluscan diversity with Bhima river pollution near Pandharpur, Maharashtra, India. Trends in Life Sciences. 1 (3): 38-42.