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CONSERVATION OF NELAPATTU BIRD SANCTUARY – A REVIEW

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ABSTRACT

Nelapattu Bird Sanctuary (Lat. 13°49' N to 31°51' N; Long. 79°57' E to 59°15' E) is located towards west of East coast of Bay of Bengal and about 20 km west of Pulicat Lake near Sullurpet, Nellore District, Andhra Pradesh. It is one of the biggest pelicanery having approximately 1500 pelicans (*Pelecanus philippensis*) breeding and roosting. It is also an ideal roosting and breeding for long distant and local migrant birds. Vertical gradient and resource partitioning of migratory birds on *Barringtonia* tree in Nelapattu Bird Sanctuary is being observed. A gradual and natural domination of open bill storks is observed over a period of time. A review on management of Nelapattu Bird Sanctuary is described for ecological sustainability which include irrigation water management, deweeding and prevention of algal bloom, *Prosopis juliflora* plantation for roosting of birds, plantation of Subabul trees for procuring nesting material. Feeding of Krishna river water to last only up to May/June 1st week only to avoid stabilization of new summer birds which might compete for space. A statistical relationship worked out between monsoon rainfall and pelican migration.

Keywords : Conservation, Nelapattu Bird Sanctuary pelicans (*Pelecanus philippensis*).

Introduction

Nelapattu Bird Sanctuary (Lat. 13°49' N to 31°51' N; Long. 79°57' E to 59°15' E) is located towards west of east coast of Bay of Bengal and about 20 km west of Pulicat Lake near Sullurpet, Nellore District, Andhra Pradesh. Nelapattu Bird Sanctuary can be reached as it comes on way between Naidupet and Sullurpet national highway, a deviation towards east from national highway No.5 at Doravarisatram. Naidupet or Sullurpet can be reached by train on Vijayawada-Chennai line. Nelapattu is a small village. The sanctuary is named after the village Nelapattu and notified under Wildlife Protection Act 1973 in the year 1976.

Nelapattu Bird Sanctuary is one of the biggest Pelicanery having approximately 1500 pelicans (*Pelecanus philippensis*) breeding and roosting. It is also an ideal roosting and breeding for long distant and local migrant birds. It is one of the best managed bird sanctuary in India, in view of ideal habitat, niche, predator free and life supporting ecological systems, and symbiotic relationship between Nelapattu village farmer community with least disturbance of birds. Though it is well managed bird sanctuary for ecological sustainability, a few management suggestions are made from what an ecologist and naturalist views. The sanctuary area is approximately 458.92 ha and consists of freshwater ponds in core area of 82.56 ha with mostly *Barringtonia trees* which grow in water bodies and *Prosopis juliflora* on tank bund where the birds roost. The water body also consists of very few *Prosopis juliflora* thorny plants. Both these plants are nesting and or roosting sites for winter migratory birds: pelicans, open bill storks, white ibis, coots, cormorants, large egrets, little egrets, spot billed ducks, gadwall, shoveller, teal, tern, stilt, pond herons, moorhen, coot, night heron, spoon bill, pin tail, and a variety of waders numbering more than 60 species as per earlier record Nelapattu Bird Sanctuary Brochure, Andhra Pradesh, Department of Forest (1996). The total number of birds check listed includes both long distant wintering migratory birds, local migrants, aquatic and terrestrial birds including common kite, crow, sparrow, koel, owl, doves, etc. amounted to 186 species (Sharma and Raghavaiah, 2002). In the present context only wintering migrant birds are taken into consideration in view of their importance. However, the diversity indices vary and the number of only winter migrants species mentioned above and in earlier records seem to show a decrease. At present number of wintering bird species vary from 21-28 species. The niches of these birds appear to overlap but each species or group of species roosts and nests in vertical gradient in specific areas of trees or grassy wetland below thus partitioning the space resource and minimizing overlap and reduce competition among different species (Terborgh, 1977

Pelican migration is associated with northeast monsoon and amount of rainfall as inferred in a study in Nellapattu Bird Sanctuary.

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and Kattan and Franco, 2004). The resource partitioning by vertical gradient of birds is an evolutionary adaptation that reduces the harmful effects of interspecific competition (Nanda Kumar *et al.,* 2009b). Mention is made only on wintering migratory birds in the management plan (distant and local migrants). The feeding grounds for Nelapattu birds are Pulicat Lake (Nanda Kumar *et al.,* 2008; 2009a, b, d and Nagarjuna *et al.,* 2010b).

Material and Methods

The coast line of the Bay of Bengal from Kavali to Chennai is approximately 200 km. The rainfall amounts were recorded from daily weather INSAT satellite imagery chart and data of India Meteorological Department (IMD) and Meteorological Department, Chennai, India provided to National News Media. The mean rainfall amounts of Kavali, Nellore and Chennai are recorded. The INSAT Satellite imageries were retrieved from News media weather charts provided by India Meteorological Department, Pune and Chennai.

Birds were identified as described by Ali and Repley (1968). Bird numbers were observed by direct observation and counted at 6.00 to 6.30 p.m. using binoculars. The bird numbers were counted during bird arrival from September to December every year and also with technical help from the Divisional Forest Officer, Government of Andhra Pradesh Sullurpet, Nellore District who manage Nelapattu bird sanctuary. Photographs of pelicans were taken before rainfall, and after rainfall. The bird numbers were counted and the rainfall amounts were recorded from September to December for the years from 2006-2010. Birds arrive in graded batches lasts upto December depending upon rainfall pattern and the adult pelican numbers remain the same from December onwards and raising chicks in December/January.

Results and Discussion

Vertical gradient and resource partitioning of migratory birds on *Barringtonia* tree in Nelapattu bird sanctuary

The winter migratory birds pelicans, open bill storks, white ibis, cormorants, large egrets, little egrets, ducks etc. occupy different specific areas of trees and show a vertical gradient or strata (Figs. 1, 2a & 2b). The top branches of the tree or canopy are occupied by pelicans and open bill storks, followed by white ibis and at lower level strata, egrets, herons and cormorants. The ducks, shovellers and a few waders are observed in the lower most strata i.e., the water surface containing water weeds or wild grass. Thus a vertical gradient is visualised. It is interesting to note that the pelicans and open bill storks occupy canopy branches at highest level or strata level one, white ibis strata level two, cormorants and pond herons occupy the lowest branches at strata level three and ducks at shallow water surface level near wild grass and thus without competition the birds co-exist (Figs. 1 and 2a). Thus space is partitioned without competition and they co-exist. Ecological gradients were observed in different situations also (Terborgh, 1977 and Kattan and Franco, 2004). It is likely that the pelicans and open bill storks occupy the sturdy top branches as they are large birds (the wing span up to 5 feet) whereas pond herons and cormorants are relatively small birds occupying lower branches of the trees.

How bird diversity indices value helps in management

Simpson Diversity Indices: Simpson diversity indices of winter migratory birds were calculated for Nelapattu Bird Sanctuary based on number of only wintering species visit. The biodiversity index namely Simpson Index, Simpson Biodiversity Index are calculated year wise for four years from 2006-2010 and compared for the benefit of ornithologists, environmentalists and naturalists to enable periodical monitoring of diversity index because any change in indices would indicate either new addition of bird species or absence in these bird sanctuaries or major environmental or ecological impact or changes.

The number of bird species varies in each year for the period recorded from 2006 to 2010. In the year 2007-2008 (September to April) highest numbers of birds were recorded followed by 2009-2010. The statistically significant association of pelican numbers to rainfall was also reported earlier. The total rainfall in 2007-2008 and 2009-2010 was comparatively higher than other years i.e., 2006-2007 and 2008-2009. The total population number of 20 bird species (occasionally other species) for the year 2007-2008 was 1601, followed by 3888 in 2009-2010 and for the year 2006-2007 and 2008-2009 it was 2857 and 2780 respectively (Table 1a). It should be noted that though different bird population numbers were varying there was not much variation in Simpson Index and Simpson Diversity Index. The Simpson Diversity Indices were 0.82, 0.83, 0.73 and 0.77 for the years 2006 to 2010 and corresponding Simpson Indices were 0.18, 0.17, 0.27 and 0.23 (Table 1b). The mean Simpson Diversity Index of Nelapattu for four migratory seasons was 0.78 and Simpson Index was 0.21. It is very interesting to note that though bird species population variation existed, the biodiversity index did not alter appreciably obviously indicating role of species variation in biodiversity index.

A gradual and natural domination of open bill storks

Based on observations it is stated that there seem

Table 1a: Listing of migratory birds of Nelapattu Bird Sanctuary during December/January from 2006-2010.

Sl.No.	Birds	2006-07	2007-08	2008-09	2009-10
1	Grey pelicans	800	1405	964	1391
2	Open bill storks	670	1050	996	992
3	White ibis	350	1180	305	328
4	Cormorants	450	1210	300	591
5	Large egrets	150	360	18	11
6	Little egrets	120	360	37	198
7	Cattle egrets	250	400	46	200
8	Grey heron	20	30	19	
9	Indian moorhen	3	2	8	18
10	Coot	4	40	12	28
11	Dab chicks	4	25	8	31
12	Pond heron	4	6	7	31
13	Red wattle lap wing	4	3	4	15
14	Pin tail	8	10	36	14
15-18	Other bird species (pochard, teal, gadwals, Tern, etc.,)	20	20	20	20
	Total	2857	6101	2780	3888

The chick numbers are not counted which are observed mostly in January.

to be a gradual domination of open bill storks occupying the top canopy branches along with pelicans on *Barringtonia* tress of Athigunta over a period of 30 years of observation. The open bill storks have occupied about 70% of canopy of Athigunta *Barringtonia* trees (Figs. 2c). This resulted in a gradual occupation, nesting and roosting on *Prosopis Juliflora* trees planted on the tank bund on North-western side of Athigunta tank. However, as a remnant of pelicans presence two or three *Barringtonia* trees on the western side of Athigunta have only pelicans whereas on the eastern side only open bill storks. At present the so called biggest pelicanery Nelapattu with more than 1500 birds (Fig. 3a) are present mostly on the northern and North west side of Athigunta. The reason being that open bill storks arrive earlier around July/August/September whereas pelicans arrive October/November and even during December depending upon the rainfall (Nanda Kumar *et al.,* 2009e) during Northeast monsoon.

Management of space partitioning for pelicans and tree plantation

It is recommended to plant *Prosopis juliflora* towards western side of Athigunta. The plantation distance, keeping in view the growth of tree, should be 50ft between canopy to canopy to avoid over crowding and place for pelicans for swimming.

Prosopis juliflora trees with minimum 10 to 15 ft height can be transplanted on tank bed in June when water is dry. The side branches can be cut leaving centre branch for easy transportation and transplantation. Initially same tree wood can be used to support the plant. Over a period of 2 or 3 years tree grows well and can be an ideal site for roosting and nesting. Similarly each *Prosopis* sp. can be planted alternatively with *Barringtonia* tree.

New colonization on northern side of Athigunta on *Prosopis juliflora*

An interesting observation was that a few pelicans have occupied *Prosopis juliflora* on top branches of the northern most side of Athigunta. They have occupied because water was present on the north and north western side (Fig. 4). The wild creeper on *Prosopis* sp. acts as mesh creating a cushion bed like structure for nesting to pelicans.

Management of western, north western and northern side of Athigunta by deweeding *Ipomea* sp. water weeds

In view of new colonization by pelicans on *Prosopis juliflora* the above said north western and northern side needs the deweeding/removal of emerging *Ipomea* sp. plants deweeding these plants reduce siltation and also restores the tank with appropriate level of water and which is a main defense mechanism for roosting migratory birds.

Restoration of *Eragrostis tenella*

Ipomea sp. have to be deweeded and the *Eragrostis tenella has* to be restored as they are nich for several waders, ducks and moorhen. It also acts as a camouflage for lower strata nesting birds like purple moorhen, shovellers, etc.

Prosopis juliflora are time tested roosting site of pelicans

In Nelapattu both *Barringtonia* trees and *Prosopis juliflora* trees have become ideal nesting sites of both

Table 1b: Simpson Indices and Simpson Diversity Indices of Nelapattu

	Nelapattu				
Year	2006-07	2007-08	2008-09	2009-10	Mean
Simpson Index	0.18	0.17	0.27	0.23	0.21
Simpson Diversity Index	0.82	0.83	0.73	0.77	0.78

Fig. 1 : Pelicans roosting at higher strata level (canopy) of a tree in Nelapattu Bird Sanctuary

pelicans, open bill storks, white ibis, cormorants, etc. For example in Uppalapadu of Guntur District the nesting sites are *Prosopis juliflora* only (Fig. 5). Hence in Nelapattu also *Prosopis juliflora* can be planted in summer at a distance of 50 ft allowing a gap of 50 ft between side branches of *Prosopis juliflora* or *Barringtonia* tree. This would allow more space for nesting than at present for pelicans and other migratory birds.

Caution

Prosopis juliflora has high propagation capacity hence the forest official have to be careful and monitoring in removing its excess growth of *Prosopis juliflora* while maintaining a reasonable gap of 50 ft

Fig. 2a : Three strata levels of birds. Level I open bill storks, Level II white ibis and Level II cormorants of a tree in Nelapattu Bird Sanctuary. Dab chicks are amidst water weeds and wild grass at pond edge.

Fig. 3a : Pelicans colonization on *Prosopis juliflora* on the north and north western side of Athigunta. Here the pelicans dominate in colonization and nesting (close view)

Fig. 2b : Domination of Open bill storks on *Barringtonia* trees in Athigunta part of sanctuary (long view)

Fig. 4 : New colonization on northern side of Athigunta on *Prosopis juliflora*. A wild creeper acts as soft bed binding *Prosopis* branches.

Fig. 5 : Pelicans on *Prosopis juliflora* in Uppalapadu

Fig. 6b : Open bill stork alighting to pick up a twig on Subabul tree *(Leucaena leucocephala*) adjacent to Uppalapadu bird protected area.

Fig. 6a : Flock of open bill storks on a Subabul tree adjacent to Uppalapadu bird protected area for picking up slender shoots of canopy.

Fig. 6c : A flying open bill stork carrying Subabul twig towards Uppalapadu nesting site.

Fig. 8a : Pelicans roosting at Nelapattu bird sanctuary

Fig. 8b : Feeding at Pulicat Lake sea mouth shallow water

between canopy for swimming by pelicans and other waders.

Management of Neredugunta site of sanctuary

The Neredugunta which lies on the northern side of Nelapattu sanctuary is also a catchment area of rain water. Though it is a larger area compared to Athigunta, is very sparse in number of plants. While leaving a larger area for swimming for pelicans a few more *Prosopis juliflora* and *Barringtonia* trees can be planted alternatively to provide nesting and roosting facility. At present the water is shallow and is gradually succeeded and dominated by *Ipomea* sp. water weeds. Plantation of *Barringtonia* and *Prosopis juliflora* can be done

alternatively while maintaining reasonable distance. This would enhance the nesting facility of pelicans and other migratory birds.

Plantation of Subabul trees – A nesting material for open bill storks

A recent observation by Nagarjuna *et al.* (2011) was that at Uppalapadu, the Open bill storks cut the tender shoots with their beaks, bring and nest [Figs. 6(a,b,c & d)]. Hence it is recommended to plant four or five Subabul trees in the reserve forest area of Nelapattu which would be beneficial for open bill storks for nesting their nests.

Algal bloom at Athigunta

Growth of algae and its bloom is noted for the first time on the Southern side of Athigunta where the concrete pathway starts towards tank bund of Athigunta. The reason for algal bloom is leaching out of organic debris from southern reserve forest area from the humus. The algal bloom has to be removed and leaching of humus organic nutrient can be prevented by raising the southern side bund level. It should be noted that the reserve forest area humus accumulated over many years is very essential for health of reserve forest only. The algal bloom some how has to be removed as its progression further into Athigunta would be a hindrance for swimming pelicans and other waders and would also cause foul smell and contain phycotoxins (Thomas *et al.,* 2007). The process is known as eutrophication. This process has to be prevented.

Irrigation water in the tank should be present only up to May/June 1st week and management and regulation of Telugu ganga feeder

The Nelapattu Bird Sanctuary has Athigunta and Neredugunta irrigation tank, the core area of bird sanctuary. The water level in the tank around nesting site of plants is a defense mechanism for many centuries. The migratory birds season commence from September/October to April/May 1st week. By this time the migratory birds emigrates back to their place of origin. Any interference in this natural timing of birds season should be avoided. If Telugu ganga water is used as a feeder for restoring water level it has to be appropriately regulated to last only up to May 1st/2nd week only. Excess water overstaying beyond May and up to July would attract new summer species residents whose nesting would overlap and their stay also overlap with usual migratory birds listed in the earlier section and would result in competition with natural wintering migrants.

For centuries Nelapattu migratory season lasts from August/September to April/May. This season correlates to water level in tank. Above conclusion is made because in Uppalapadu, Guntur District, a space constrain and space partitioning and overlapping is observed by investigator (Nanda Kumar *et al.,* 2010a, c, d) due to presence of water throughout the year due to Krishna water supply. Hence in Nelapattu, status quo has to be maintained and however, water can be supplied by Telugu ganga feeder only when tank water level is less but should last only upto April/May.

The second tank towards West is scarce in water and sparse in *Barringtonia/Prosopis*. These trees can be planted with 50 ft distance between expected canopy to canopy to allow more number of birds to nest. Water may be supplied to last up to April/May months only as this tank quickly dries up.

Action plan during deficient rainfall

Water from Telugu Ganga can be supplied to maintain water level and needs appropriate regulation of water as mentioned above during deficient rainfall.

Monitoring monsoon rainfall and chronobiology of pelican migration to Nelapattu and feeding grounds of Bay back waters of Pulicat Lake

The long distant migratory bird pelicans (*Pelicanus philippensis*) which visit during North East monsoon from October/November onwards, roost and breed upto March/April. A correlation between migration of pelican birds arrival to Nelapattu for roosting and for feeding to Pulicat Lake and their gradual increase in population in relation to rainfall amounts and cyclonic storm pattern, after on set of North East monsoon in the Bay of Bengal/Indian Ocean was recorded. Importantly, this season is well known for low pressure or deep depression or cyclonic storm formation in the Bay of Bengal bringing copious rains to South coastal Andhra Pradesh and Tamil Nadu. The season is also associated with North to South East to West diagonal wind pattern in India. It is hypothesized that monsoon wind pattern, change in temperature, rainfall in South originating from Bay of Bengal and Indian Ocean due to sweeping down of winds from Plateaus of Asia and Himalayas and brings rain and cooler weather to South East coast of India between October and November might act as one of environmental stimuli. The research paper describes relationship between pelican numbers which feed in Pulicat Lake brackish water lagoon extended in 640 sq km which are formed out of back waters of the Bay of Bengal and roost after feeding in Nelapattu (Nanda Kumar *et al.,* 2009e).

The Table 2 gives weekly mean rainfall amount for the years 2006, 2007, 2008, 2009 and 2010 from September to December. The mean rainfall amounts of

Table 2 : Correlation of pelican (*Pelecanus philippensis*) migration and numbers to North East monsoon and rainfall amounts

	Premonsoon				North East monsoon season											
Year 2006	September				October				November				December			
Week	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Rainfall (mm)	205.66	210.00	265	300.33	22.66	23.66	43.00	384.66	473	537	701	702	705	719	719	724
Pelican Numbers	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	200	540	750	800	800	800
Year 2007	September				October				November				December			
Week	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Rainfall (mm)	443	443	452	501	1.66	2	26.33	647	728	728	751	755	766	783	871	878
Pelican Numbers	Nil	Nil	Nil	Nil	200	200	200	500	500	1326	1350	1360	1360	1370	1400	1405
Year 2008	September				October				November				December			
Week	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Rainfall (mm)	241	262	268	328	0	36	182	328	328	332	372	690	714	719	719	719
Pelican Numbers	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	506	542	542	542	542	632	910	964
Year 2009	September				October				November				December			
Week	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Rainfall (mm)	234	234	237	277	1.5	2	2	45	374	557	609	623	703	716	770	798
Pelican Numbers	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	7	576	1008	1013	1258	1309	1340	1346
Year 2010	September				October				November				December			
Week	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Rainfall (mm)	469	497	519	537	40	50	75	93	449	543	629	661	724	767	803	803
Pelican Numbers	2	2	2	2	2	170	1028	1598	1587	1579	1580	1580	1580	1586	1584	1596

RainfalI: Mean rain amounts of Chennai, Nellore and Kavali covering 200 km South East coast of the Bay of Bengal

Table 3 : Table showing statistical correlation between pelican numbers and rainfall

	Year	Month	r value	p value	Significance	Sample
Rainfall Vs pelican Numbers	2006	November	0.819	0.181	ns	4
Rainfall Vs pelican Numbers	2006	December	0.958	0.042	*	4
Rainfall Vs pelican Numbers	2007	October	0.999	0.001	**	4
Rainfall Vs pelican Numbers	2007	November	0.601	0.399	ns	4
Rainfall Vs pelican Numbers	2007	December	0.997	0.003	**	4
Rainfall Vs pelican Numbers	2008	November	0.392	0.608	ns	4
Rainfall Vs pelican Numbers	2008	December	0.710	0.290	ns	4
Rainfall Vs pelican Numbers	2009	November	0.978	0.021	*	4
Rainfall Vs pelican Numbers	2009	December	0.896	0.104	ns	4
Rainfall Vs pelican Numbers	2010	October	0.990	0.001	**	4
Rainfall Vs pelican Numbers	2010	November	0.976	0.020	*	4
Rainfall Vs pelican Numbers	2010	December	0.975	0.019	*	4

ns = Not Significant * = Significant at 0.05 level ** = Significant at 0.01 level

200 km the Bay of Bengal coast line at Kavali, Nellore and Chennai was recorded (Table 2 and Fig. 7). The total rainfall and pelican numbers showed statistical correlation (Table 3). In the year 2006 the total rainfall from September to December was 717 mm and pelican (adult) number was 800. In the year 2007 the total mean rainfall was 824 mm and total pelican (adult) numbers recorded were 1405. In the year 2008 total mean rainfall was 718 mm and pelican number was 964 and in the year 2009 total mean rainfall was 747 mm and pelican

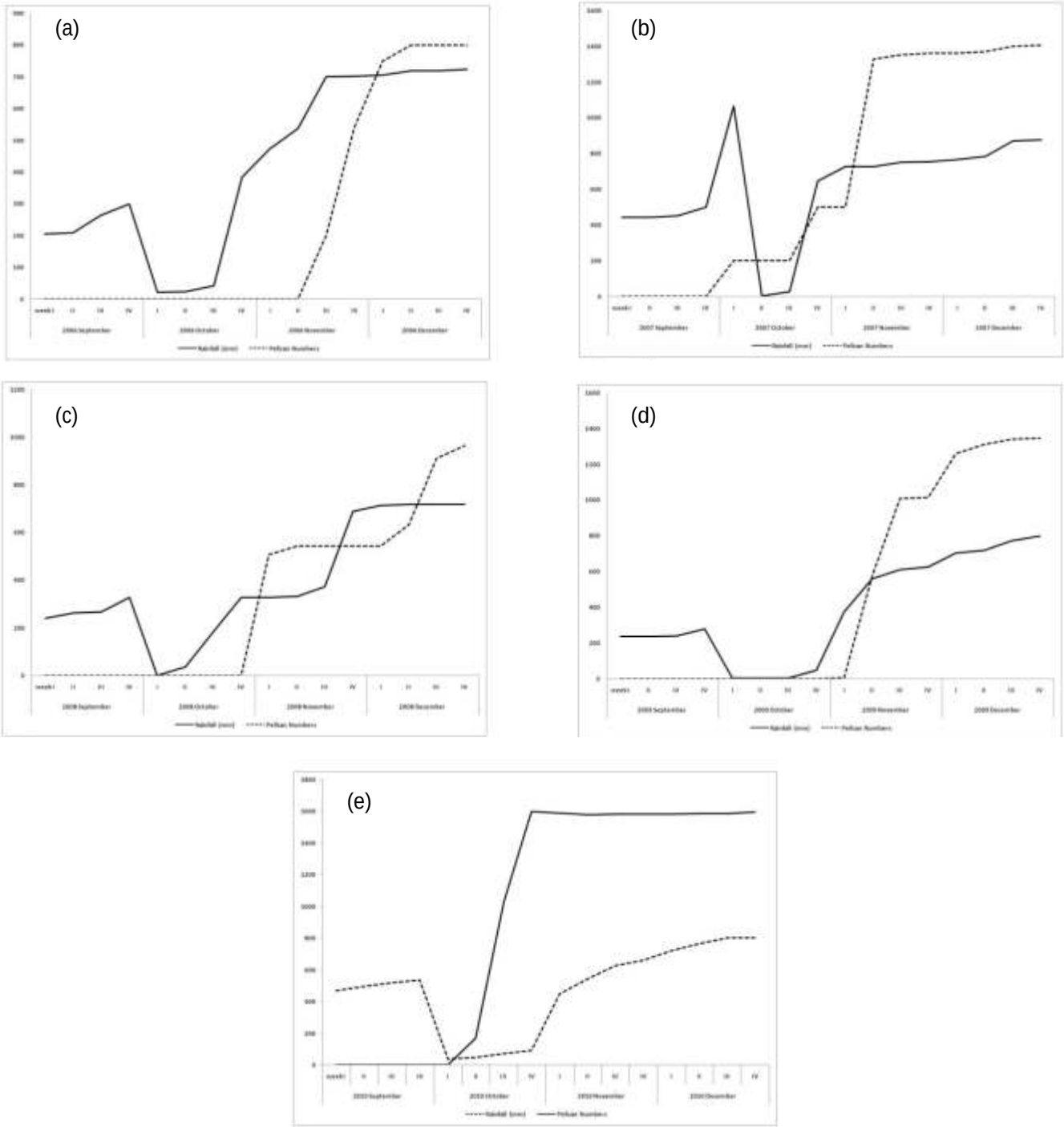

Fig. 7 (a,b,c,d & e) : Graph showing North East monsoon rainfall amounts from October to December and pelican numbers from 2006-2010.

number was 1346. In the year 2010 total mean rainfall was 774 mm and pelican number was 1596. The pelican numbers not only were dependent on total rainfall but also show correlation to graded rainfall amounts. However, in the year 2008, rainfall amount in October was scanty recording 136.5 mm and pelican numbers were nil. Whereas the same year in November 2nd to 4th week the rainfall amount was 332 mm, 372 mm and 690 mm respectively and the number of pelicans was 542. Whereas in December the rainfall amount was 719 mm correspondingly the pelican numbers were 632, 910 and 964, thus showing an apparent correlation but not statistically significant correlation to rainfall. These birds feed in adjacent Pulicat Lake lagoon where shallow water regime is observed i.e., from Rayadoruvu to Venadu areas.

It is hypothesized and presumed from above satellite pictures of cyclonic storms [Fig. 9(a-l)] and wind

pattern originating from Northern Peninsular India during North East monsoon, changes in temperature regime of the Bay of Bengal which is perceived as major physical change might induce a confident pelican's migratory instinct. Obviously the water tank is filled in Nelapattu and is a safe roosting site and haven for pelicans with Pulicat Lake as feeding grounds.

Pelican migration associated with monsoon rains, low pressures, depression and cyclones of Bay of Bengal: The fig. 9(a-l) INSAT Satellite imagery showing monsoon clouds, depression, storms and atmospheric changes above South East Bay of Bengal during North East monsoon. In our observation we opined that when monsoon is active and brings required amount of rain along South East coast of India the pelicans arrive at Nelapattu. The Table 2 and fig. 7(a-d) show mean rainfall amounts and pelican numbers recorded weekly and month wise for the year 2006-2010. It is a significant observation that pelicans arrive in batches in graded numbers with gradual increase in numbers depending on graded increase in rainfall amounts [Table 2 and Fig. 8(a,b)]. A model recording of INSAT Satellite pictures are shown for the year 2009 for the months September to December to substantiate above presumption. The INSAT picture Fig. 9a showed a clear cloud-free South East on Bay of Bengal on September 10th 2009. The monsoon was less active recording 234 mm, 237 mm and 277 mm in I, III and IV week of September 2009 respectively recording absence of pelicans. Whereas similar situation existed until 29th October recording only 1.5 mm, 2 mm, 2 mm and 45 mm rainfall. The INSAT fig. 9b showed active monsoon along South East coast of the Bay of Bengal on 29th October followed by high rainfall amounts within a few days i.e., in November recording mean rainfall amount (200 km South East coast line) 374 mm, 557 mm, 609 mm and 623 mm in I, II, III and IV week respectively. Accordingly pelicans arrival followed and their number showed a gradual increase. The INSAT pictures fig. 9(c-h) showed monsoon activity with cloud formation, a visible change in atmosphere recording heavy rainfall as mentioned above in 2009. The pelican numbers in Table-2 show 7, 576, 1008 and 1013 pelican numbers in I, II, III and IV week respectively at roosting site in Nelapattu Bird Sanctuary thus corresponding to rainfall amount in the year 2009. The pelicans arrived in graded increasing number from 7 to 1013 showing a direct correlation to rainfall amount (Table-3). Interestingly one important observation was that the 1st batch of seven pelicans which visited in first week of November presumed to act as indicators or pilot pelicans initiating a follow up by 576, 1008 and 1013 pelicans in I, III, III and IV week of November 2009.

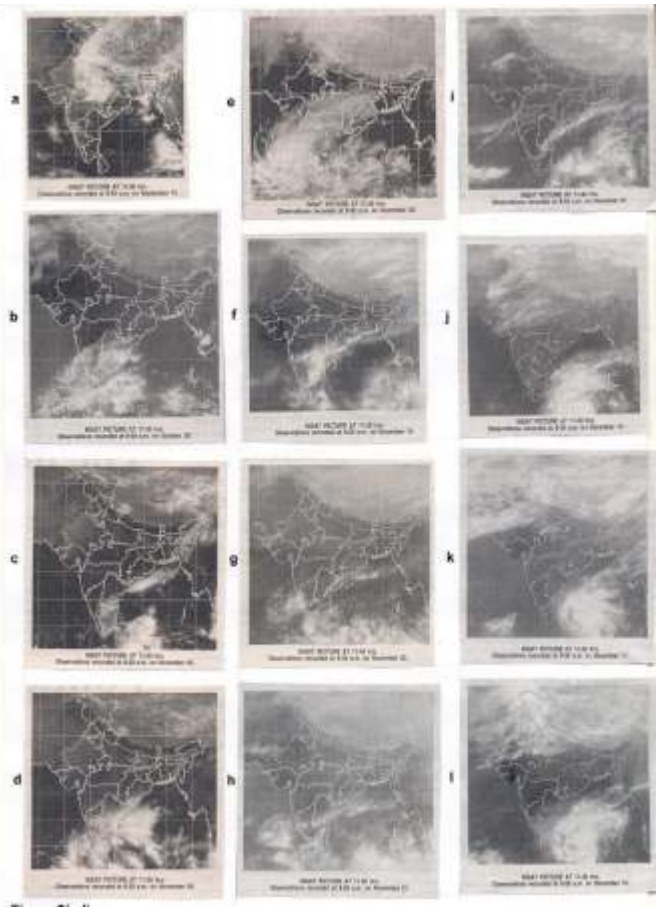

Fig. 9(a-l): INSAT Satellite pictures showing monsoon clouds, cyclone storms/depressions in Bay of Bengal for the model year 2009 which bring rainfall to South East coast of Bay of Bengal. See North East monsoon clouds 9(b-h) and cyclonic storm and depression 9(j-l).

Further the INSAT fig. 9(i-l) showed active monsoon, low pressure turning into deep depression (Fig. 9k) and a cyclonic storm fig. 9(l). These atmospheric physical factors i.e. low pressure and depression over Bay of Bengal resulted in heavy rainfall and the total cumulative mean rainfall (November +December) was 703 mm, 716 mm, 770 mm and 798 mm respectively, coincidentally the pelican numbers recorded at roosting site at Nelapattu Bird Sanctuary (Table-2) was 1258, 1309 and 1346 in I, II and IV week of December 2009 respectively. Similar trends were observed for the years 2006, 2007 and 2008 showing graded rainfall amounts and pelicans numbers (Table-2) and statistical correlation (Table-3).

North East monsoon and cyclone storms of the Bay of Bengal along South East coast of Peninsular India which bring heavy rainfall associated with major physical changes (Kripalini and Kumar, 2004; Kothawale *et al.,* 2008 and Baviskar, 2009) presumed to act as one of external environmental stimuli for migration of pelicans (*Pelecanus philippensis*) to roosting site Nelapattu and its feeding grounds Pulicat Lake, the second largest brackish

water lagoon of India formed out of back waters of the Bay of Bengal (Nanda *et al.,* 2009e and Nagarjuna *et al.,* 2010b). A five year study on chronobiology of pelicans, long distant migratory birds, was studied for the period from 2006 to 2011 showed correlation to rainfall amounts. It is hypothesized and presumed from satellite pictures of cyclonic storms coupled ocean atmospheric dynamics originating from Northern Peninsular India during North East monsoon, changes in temperature regime of the Bay of Bengal which might be perceived as major physical changes inducing a confident pelican's migratory instinct. To augment confident pelican migration to Nelapattu, a close watch and monitoring of rainfall amount have to be kept. If there is deficient rainfall, the tank water has to be saved and optimum water level has to be maintained to create confidence for pelicans for breeding and roosting. As it is an irrigation tank, the farmers also have to be satisfied for paddy cultivation. To satisfy both pelicans (other migratory birds) and farmers feeder by Telugu Ganga water to Nelapattu tank have to be planed for optimum water level. Caution have to be taken to see that water level should last only up to May 1st week only and not beyond as overlapping of nesting by new arrival of summer roosting birds will cause nesting space constraint.

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नेलापट्टू पक्षी अभयारण्य का संरक्षण - एक पुनरीक्षण

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सारांश

नेलापट्टू पक्षी अभयारण्य (अक्षांश 13^0 49' एन से 31^0 51' एन; देशान्तर 79^0 57' ई से 59^0 15' ई) बंगाल की खाड़ी के पूर्वी तट के पश्चिम और सूल्लूरपेट, नेल्लौर जिला, आन्ध्र प्रदेश के नजदीक पूलिकेट झील के करीब 20 किमी. पश्चिम की ओर स्थित है। यह सबसे बड़े श्वेत जलपक्षी स्थल में से एक है, जहां लगभग 1500 श्वेत जलपक्षी (*पीलीकेनस फिलीपीन्सिस*) प्रजनन और बसेरा करते हैं। यह लम्बी दूरी से आने वाले और स्थानीय प्रवासी पक्षियों के लिए भी एक आदर्श बसेरा और प्रजनन का स्थान है। नेलापट्टू पक्षी अभ्यारण्य में बेरिंगटोनिया वृक्ष पर प्रवासी पक्षियों के उर्ध्वाधर अनुपात एवं संसाधन विभाजन का प्रेक्षण लिया जा रहा है। लम्बे समय में ओपन बिल स्टोर्क की धीरे-धीरे एवं प्राकृतिक प्रधानता देखी गई। पारिस्थितिकीय पोषणीयता के लिए नेलापट्टू पक्षी अभयारण्य के प्रबन्धन पर एक पुनरीक्षण का वर्णन किया गया है, जिसमें सिंचाई जल प्रबंध, पक्षियों के बसेरे के लिए *एल्गल ब्लम, प्रोसोपिस जूलिफोरा* रोपण की विनिराई तथा रोकथाम, घोंसला निर्माण पदार्थ प्राप्त करने के लिए सूबबूल वृक्षों का रोपण करना शामिल है। गरम में नए पक्षियों, जो स्थान के लिए स्पर्द्धा कर सकते हैं, के स्थायीकरण से केवल बचने के लिए कृष्णा नदी जल का भरण केवल मई/जून प्रथम सप्ताह तक चलता है। मानसून वर्षा और श्वेत जलपक्षी स्थानान्तरण के बीच एक सांख्यिकीय संबंध की गणना की गई है।

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