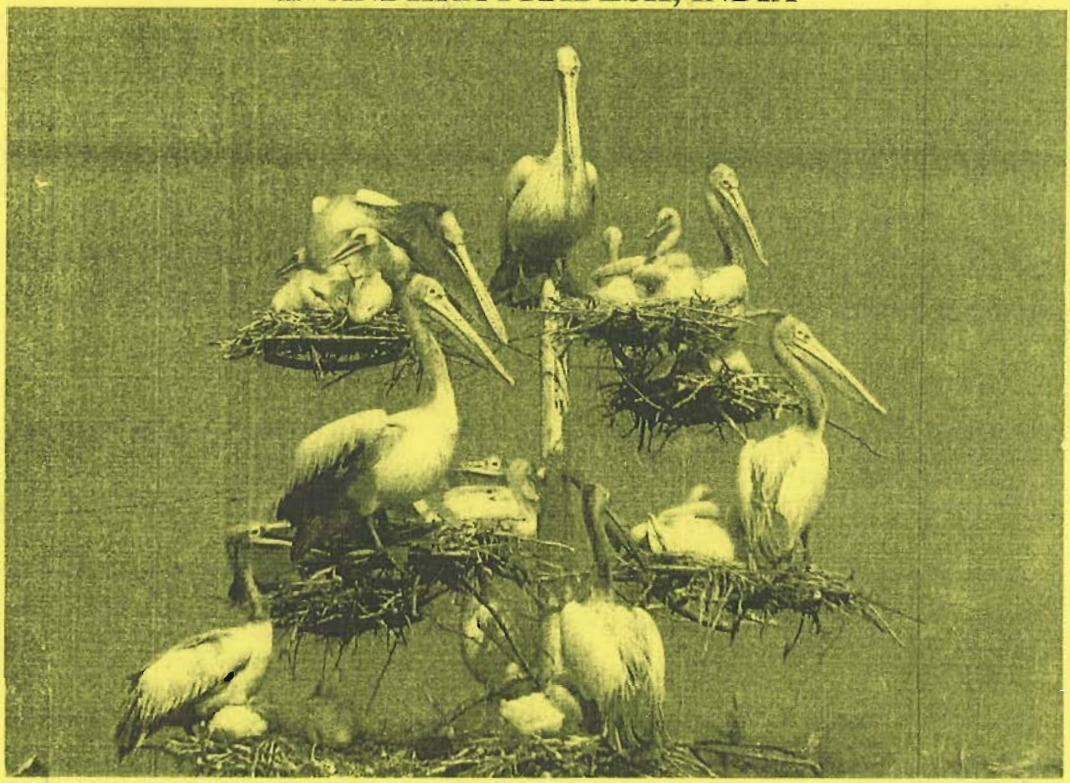
ECOLOGY AND CONSERVATION OF THE SPOT-BILLED PELICAN *PELECANUS PHILIPPENSIS* IN ANDHRA PRADESH, INDIA



FINAL TECHNICAL REPORT

SUBMITTED TO THE
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SACON

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N. Sheeba

CONTENTS

INTRODUCTION

Wetlands are the important bird habitats and birds use them as migratory resorts or for breeding, feeding and roosting. Birds are one of the best indicators of the status of a wetland. Many waterbirds are obligately tied to wetlands for most or all of their life cycle (Susan *et al.* 1998). Changes in wading bird number, location and nesting efforts were studied to assess the health of wetland ecosystems (Crozier & Gawlik 2003). Ecology, survival rate, contamination and spatial aspects of colonial waterbirds biology continue to serve as sensitive bioindicators of environmental changes, as they respond rapidly to changing conditions (Kushlan 1993; Weller 1999; Bryan *et al.* 2003). Examining the environmental correlates of species distribution and life history traits is one of the best protocols to assess the indicator properties of target species groups. The Spot-billed Pelican is one of the near threatened species found in India. It breeds in Andhra Pradesh and Tamil Nadu in India, and Sri Lanka. This bird is subjected to local migration for food and breeding site. Determining the habitat use and factors affecting the habitat use are important for conservation and management of any species. To have insight into the real threat of this near-threatened species in inland wetlands of Andhra Pradesh and for conservation, immediate attention is needed to address their status, ecological requirements for feeding, breeding and other vital activities.

Therefore the present study has been carried out with the following objectives:

- Assess the current status and population of the Spot-billed Pelican in Andhra Pradesh
- Evaluate habitat requirements and factors determining habitat selection.
- Understand its foraging and breeding ecology
- Examine potential threats to the population of this species and suggest conservation measures

The following outcomes are presented in different sections:

1) General introduction to the study and literature review.
2) Account of intensive study area and study species.
3) Current status of the Spot-billed Pelican is assessed with the colony site dynamics in Andhra Pradesh.

4) Nesting habitat characteristics and breeding performance of the Spot-billed Pelican in Uppalapadu bird habitat.
5) Foraging Foraging behaviour and food of the chick
6) Activity budget of the Spot-billed pelican in the Uppalapadu bird habitat during the breeding season.
7) Summary and conclusions with conservation needs and site specific actions.

STUDY AREA

Uppalapadu water reservoir

In the Deccan Plateau, a large number of man-made inland irrigation tanks play an important role in providing feeding and nesting habitats for colonial nesting birds (Subramanya 1996). The study was conducted at Uppalapadu bird habitat (16^0 16' 26" N, 80 ^{0} 21' 58" E), located about 7 km East of Guntur, Andhra Pradesh, India. Uppalapadu is one of the Important Bird Areas (IBAs) in India (Islam & Rahmani 2004) and this area falls under waterlogged area of less than (<) 56.25 ha eligible to be declared as a Ramsar site (Vijayan *et al.* 2004). Uppalapadu is known for the Spot-billed Pelican since 1999. The field study was carried out between February 2007 and April 2010.

Currently, the 14 ha reserve is used to fulfill the villagers' water demand. In this 2.54 ha was reclaimed for high school buildings which comprise the Jilla Parishad school (Local Government School) building, play ground and stagnant puddle which is bordered by a few *Prosopis juliflora, Acacia nilotica and Eleocharis acutangula.* Of this, 1.31 ha currently function as buffer zone for the bird reserve with nesting birds (Fig. 1).

Fig. 1. Current boundary of water tank at Uppalapadu Village.

Remaining 11.46 ha of tank is used to store water for domestic purposes. Changes of land use pattern and poor maintenance lead to rapid growth of *Prosopis* in the pond. It provided roosting and nesting sites for many migratory and resident birds, namely Cattle Egret, Little Cormorant, Asian Openbill, Black-crowned Night Heron, Jacanas, Purple Moorhen and Spot-billed Duck. From 1992, Painted Storks, Black-headed Ibis and Glossy Ibis have also been visiting this tank. Nomadic Glossy Ibis use this pond only during rainy season for roosting (Rao 2002). Due to high avian density and water pollution by their excreta, foul smell became a problematic issue and polluted water became considered as cause of skin diseases. To overcome this conflict, the span of 3.74 ha was parted by bund and allotted for birds from 11.46 ha village tank. The tank is characterized by mounds with *Prosopis juliflora* and *Pithecellobium dulce*.

Water source: Uppalapadu receives water from the Krishna Western Delta Canal System (KWDS). It has a main canal length of 355.44 km in total and 1,135 km of branch canals and covers 24 mandals (Prabhakar 2007). Through this western Krishna delta, Guntur is getting water through Prakasam barrage. It reaches Uppalapadu through nearby Thekkallpadu channel.

Water depth: The water depth is more or less constant at 30 to 200 cm. and only in summer water recedes down by – 65 to 75 cm (Fig 2). During this study, water level was very low from March 2008 to June 2008 due to management activities.

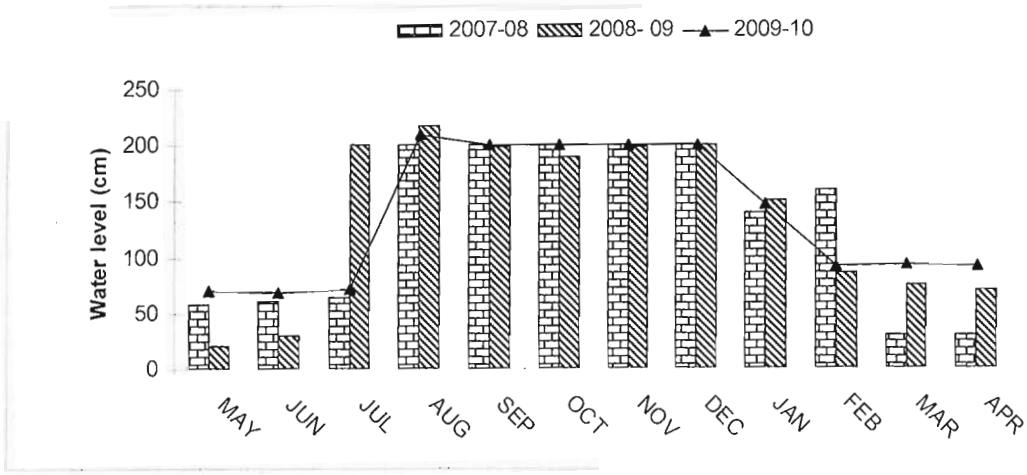

Fig 2. Water depth during the study period

Climate: The area experiences greater variations in temperature, maximum of 45°C during May and minimum of 18°C in December, and the annual rainfall is about 872.2 mm. In this 59% contribution is from South-West monsoon and 26% from North-East monsoon (Fig 3 & 4) and

peak rainfall varied between June and August. Relative humidity ranged from 30 to 80%; wind speed was calculated as 4.5 to16.3 km/hr (Prabhakar 2007).

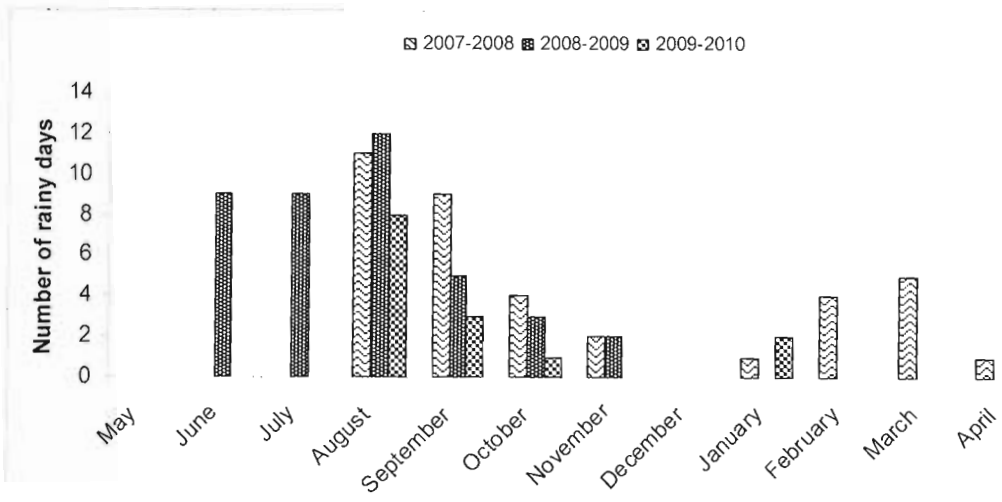

Fig.3 Number of rainy days recorded during the study period

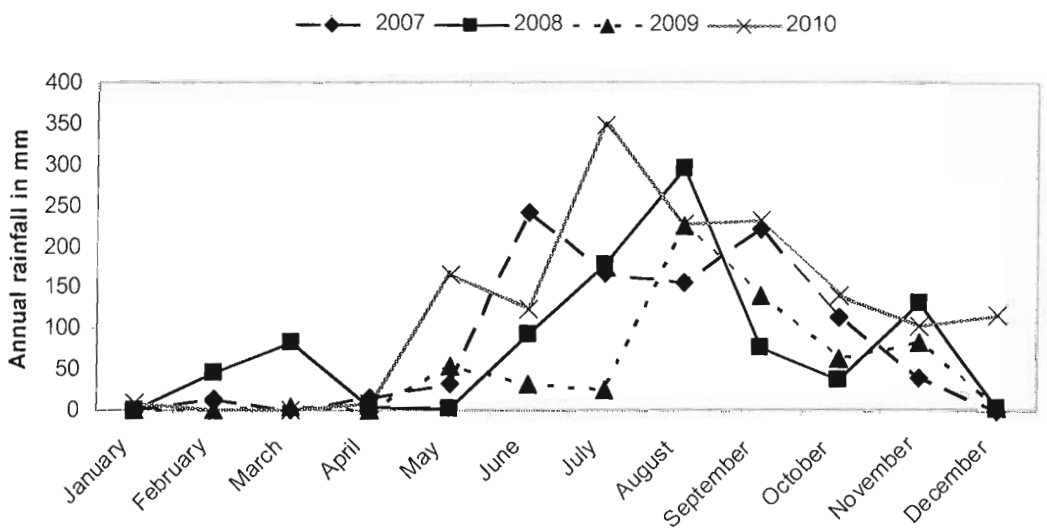

Fig.4 Amount of monthly rainfall (mm) recorded in Guntur district

Source:India Meteorological Department (http://imd.gov.in/section/hydro /distrainfall/ districtrain.html)

Physical and chemical features: This bird area is characterized by mounds in the middle of the tank with dense *Prosopis*. Totally 14 mounds were recorded. Out of 14 mounds 3 were devoid of vegetation. During later part of this study *Prosopis* saplings were planted by forest department in the vacant mounds.

Vegetation: *Prosopis juliflora* and *Pithecellobium dulce* were the chief tree species found in the study area. *Pongamia pinnata*, *Delonix regia, Leucaena leucocephala, Syzygium cumini* and *Bambusa* sp. were found along the bund. Apart from this, *Ipomoea aquatica, Ipomoea carnea, Cyperus alopecuroides, Cynodon dactylon, Paspalum distichum, Polypogon monspellensis, Eichhornia crassipes* were also identified in the tank.

Fishes: Common fish species found in this area were *Labeo rohita, Notopterus notopterus, Cirrhinus mrigala*, *Catla catla*, and *Chanda nama.*

Waterbirds: Since it meets the international criteria set by the BirdLife International in terms of supporting globally threatened birds and ranked for conservation priorities, this wetland was recommended by Vijayan *et al (*2004) for declaring it as a Ramsar site among the inland wetlands of India. The Uppalapadu bird habitat was supported by 75 species of birds belonging to 12 orders and 31 families: among these 48 species were waterbirds. Of the total of 48 species recorded, 16 species (33%) were residents, 18 species (38%) local migrants, 12 species (25%) winter visitors and 2 species (4%) were partial and occasional migrants (Appendix I & II). Twenty colonial breeders belonging to Ciconiiformes (55 %), Pelecaniformes (15%), Gruiformes (20%), and Charadriiformes (10%) used this heronry as nesting site. Occasional sightings of 2 species belonging to Orders Pelecaniformes, Ciconiiformes and Anseriformes each, and rare sightings of 1 species belonging to order Ciconiiformes are notable.

Land birds: Twenty nine species belonging to 6 orders, namely Passeriformes (62%), Cuculiformes (14%), Falconiformes (10%), Coraciiformes (7%), Piciformes (3%) and Psittaciformes (3%) were recorded in and around the study area. Among these 16% was constituted as winter visitors (Appendix II).

Mammals: Grey Mongoose *Herpestes edwardrsii* was identified from the study area.

Earlier studies in this place: Since 1999, the tracks of nesting Spot-billed Pelicans were studied by Rao & Kumar (2000), Rao & Ramana (2000) and Rao (2001, 2002, 2005). A detailed description of the area and breeding birds' status were reported by Taher (2007). A brief comparison of nesting birds with that of Nelapattu was made by Sailaja *et al.* (2007).

Threats and limiting factors

Reduction of the tank area

The major concern over wetland is area reduction. Drastic change in land use pattern has major influence on habitat destruction. After establishment of assured irrigation system the wetlands

adjacent to agricultural lands were converted in to paddy fields. The school zone with puddle is having threat of being converted to bare land and trees around this buffer zone is facing a severe threat from villagers for use as fuel wood.

Pollution

One of the major threats identified by Rao (2002) was death of nesting trees by bird dropping with highly concentrated uric acid.

Disturbances

Incidental occurrence of disturbance by firewood collectors was recorded in school zone. Fishing activity around bird protected area was also recorded. Disturbance by photographers and visitors was observed who went closer for better experience with birds.

Management action

To improve habitat, installations of artificial iron nesting poles were carried out in breeding season. For this purpose water was drained out which attracted dogs to scavenge dead fishes and subsequently nesting birds were disturbed.

Community support

Opposition from local populace was observed due to pollution of water by bird excrement which is believed to be a cause for skin disease (Rao 2002).

A landscape perspective is essential for building sound conservation programmes for water bird assemblages (Guadagnin *et al.* 2005). Based on the pressure and status of birds a detailed study of the species ecology and habitat requirement is proposed.

Breeding colonies

Surveys were carried out in four breeding colonies, namely Nelapattu, Telineelapuram, Ramachandrapalayam and Uppalapadu and 2 to 4 days' surveys were conducted in foraging sites, namely Kolleru Lake, Naupada Swamp, Kakarapally Creek and Pulicat Lake during October 2007 to March 2010 (Figure 5 and Table 1). Except Ramachandrapalayam others sites were prioritized as Important Bird Area by Islam and Rahmani (2004).

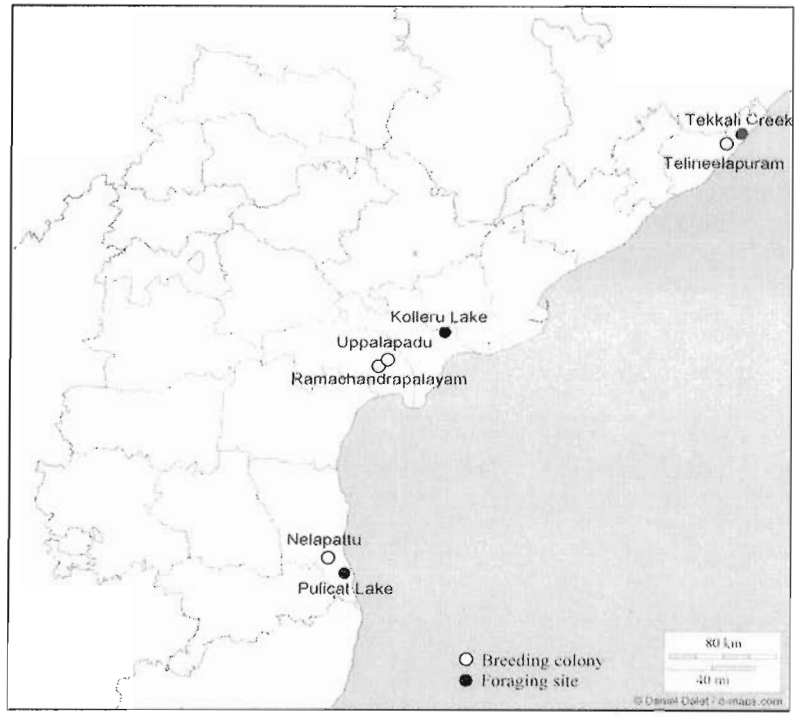

Fig. 5. Breeding and foraging sites of the Spot-billed Pelican in Andhra Pradesh

Table 1. Description of breeding and foraging sites of the Spot-billed Pelican in Andhra Pradesh

Pelicanry	Coordinates	Area	Nesting tree/habitat type	Status
Naupada Swamp & Kakarapally Creek	18° 31' 41.5" N 84° 17' 40.9" E to 18° 33' 46.8" N 84° 21' 25.6" E	15-20 km2	Marshy swamp area	Proposed Protected Area (Srinivas 2010)
Kolleru #	16° 33' 54.52"N 81° 05' 07.52"E to 16° 45' 33.86" N 81° 21' 02.84" E	901.00 km2	*Acacia nilotica*/Lake	Ramsar site (Protected)
Nelapattu Bird Sanctuary #	13° 42' 42.4" N 80° 05' 31.8" E to 13° 43'13.00" N 80° 06'54.03" E	458 ha/ 82.56 ha	*Barringtonia acutangula/Water tank*	Bird Sanctuary (Protected)
Ramachandrapalayam #	16° 17' 11.2"N 80° 29' 44.2"E	5 ha	*Prosopis juliflora/* Private fish tank	(Not Protected)
Pulicat lake	13° 42' 42.4" N 80° 05' 31.8" E	60,000 ha	brackish water lagoon	Ramsar site (Protected)
Telineelapuram #	18° 34' 04.9" N 84° 15' 56.4" E	460 ha	*Tamarindus indicus, Azadirachta indica, Ficus religiosa, Enterolobium saman* and *Prosopis juliflora*	Village Pelicanry Protected
Uppalapadu #	16° 16' 26" N 80° 21' 58" E	14 ha (3.35Ha)	*Prosopis juliflora/ Water reservoir*	Community reserve (Protected)

#=Breeding Site

METHODOLOGY

Breeding colony size and colony site dynamics

Status and colony size was estimated by the nest number. The nest estimates were doubled to obtain a breeding bird estimate (Dunbar 1982; King & Anderson 2005). Therefore observations were made from various vantage points near the pelican colonies by adapting total ground count in Nelapattu and Uppalapadu. In Telineelapuram, 45 feet high watch tower and huge building situated at the centre of the village were used to count birds. In each breeding sites total number of nests, number of active nests, and number of adult birds associated with nest, chronology of nesting activity and stages of fledged young were recorded. During this study, two surveys were conducted through the breeding season during 2007-08 to 2009-10 in order to assess the population. For the final estimate, nest number was taken into account for the population at each breeding colony (Dunbar 1982; Wilkinson *et al.* 1994; Holm *et al.* 2003; King & Anderson 2005). The nest estimates were doubled to obtain a breeding bird estimate (King & Anderson 2005).

Total bird counts were also made in loafing and foraging areas (Bibby *et al.* 1998). Census of Pelicans was carried out in other known foraging sites, namely Kakarapally creek, Kolleru lake and Pulicat lake. Vehicular surveys were conducted where lake is served with road and by feet where water body was inaccessible from road. Vantage points were selected randomly to cover whole lake area. In each wetland sites number of pelican, foraging flock size, water level, habitat type, fishing activities and fish species were recorded.

Chi-square test was performed to study the inter year variation in each breeding site.

To describe stability of a colony, we considered for each site its occupancy rate (p) that is the proportion of year, during study period. For each site turnover rate (t_i) was calculated by adapting Deerenberg & Hafner (1999), for each sites number of switches (S) between subsequent years from presence to absence of a colony at the site or vice versa, as a proportion of the total number of monitoring years (M). The index (t_i=S/M) value ranges between 0 and 1.

As an indicator of the stability in size of colonies, we calculated the coefficient of variation (CV) around the mean size (including years with size zero). The CV is equal to the Standard Deviation divided by the mean and multiplied by 100 to be expressed as percentage (Deerenberg & Hafner 1999; Anderson *et al.* 2007).

Nesting habitat characteristics and breeding performance

According to accessibility, nests were studied randomly. A sample of 619 nests (180 in 2007, 246 in 2008 and 193 in 2009) was used for the analysis of nest-site characteristics, nest-site selection (Venkatraman 2007) and breeding success. Nest tree parameters were collected during April 2008 when entire pond was drained and kept dry for three months to install two more artificial trees. Nest counts and bird counts were recorded from two sides of dikes at fixed vantage points with the help of binoculars (Pentax 8x42) and spotting scope (Nikon 20x60) (Catsadorakis & Crivelli 2001).

Arrival and settlement of birds were monitored at 2 to 3 days interval from the last week of September to 1st week of October after southwest monsoon which usually occurs during June to September (Victor *et al.* 1995). Nest initiation starts after defending site and pairing. Date of establishment of breeding subunits and spatial location relative to distance from path and colony center, nesting substrate, nest density, size of the colony and mound size were recorded. For every nest, nest tree species, distance from path, height of the colonized tree, DBH, height of the nest, vertical position and nest success were recorded. The horizontal position of nests was recorded according to Hafner (1997) and followed by SiBachir *et al.* (2008): (1) against the trunk, (2) on solid branches with vertical structure, (3) on secondary branches in the periphery of the tree or (4) in the extreme periphery.

Usually the chicks after 20–25 days leave the nest and move to other nest in the cluster, the term fledged chicks designate chicks of age up to 20–25 days. The nesting success was expressed as percentage and calculated by number of nest with young fledged from the total number of nests. Opportunistic visits were made to the breeding colony using boat (4 visits in 2007, 3 visits in 2008 and 1 visit in 2009) to check the clutch size. A total of 27 nests were observed during the study period and these were mapped for easy identification and future monitoring. In some nests, the exact date of laying of the first egg was recorded with the firm continuous sitting. For the rest, the date of laying first egg was calculated by back-dating, assuming 29-30 days for incubation (Nagulu 1983). Active nest was defined as a nest containing one or more eggs or nestlings. With marked raised sitting gesture, frequency of peeping by the adult inside nest and visible inactive pinkish head in the nest were considered as hatched and hatching success was calculated (Naik *et al.* 1981; Parasharya & Naik 1988).

Colonies were checked on a weekly basis for establishment and location throughout the breeding season. Observations on nesting birds were made from dikes in selected vantage points. Pairing, nesting and incubating adults and nests with nestling were observed. Total numbers of nests on the tree, nest height from the water level and ground level, DBH, and bole height, and distance to the nearest water spread area were collected after successful fledging of the young from the nest. The method of Catsadorakis and Crivelli (2001) and Stickney *et al.* (2002) were employed for measuring nest-site selection.

Data analysis

Index of selectivity test (Ivlev 1961) was used to evaluate preference or avoidance of various tree species as nesting sites by following formula.

$$PI = U-A/\ U+A$$

Where, 'U' denotes percent utilization of substrate and

'A' denotes percent availability of corresponding substrate.

Selectivity values of levels ranged between -1 and +1, where "-" indicates avoidance while "+" indicates preference. The nest tree types /nest substrates used by Spot-billed Pelican were recorded in six randomly plotted mounds in the heronry. For this purpose, in each mound total number of trees, total number of tree species and among them nesting and non-nesting trees were counted as described by Bertolino & Gola (2008) and Santhoshkumar & Balasubramanian (2010).

As indices of quality of breeding pairs, we used residuals from a linear regression between either reproductive success or laying date on the index of physical quality of the nest site in each season.

Differences in nesting success between early and late nesters, center and edge nesters, and neighbors and non-neighbors were examined to determine if these differences only support the Information Center hypothesis, as has been suggested (Elgar & Harvey 1987; Doligez *et al.* 2003).

Student's t-test was used to analyze significance between nesting and non- nesting trees. Pearson correlation co-efficient was used to find out the relationship between the total number of nests in a tree and other parameters. The first three highly correlated parameters were again entered into

multiple stepwise regressions with the total number of nests as the dependent factor and the selected parameters as independent factors responsible for the nest site selection.

Feeding technique and food of the chick

Regular scans were made during the daylight hours using spotting scope (Nikon 20x60). Birds were studied for flock size and feeding technique. Birds at social flocks were marked separated by their feeding and non-feeding activities and their patterns were studied. Two and more than two birds foraging at synchronized directional movements were treated as a socially foraging flock as followed by Battley *et al.* (2003). Characteristic feeding behaviour such as dipping bill, neck straightening, scooping with pouch, filtering water from bill and engulfing fish were recorded. Sometimes crushing the fish between the bills were also observed. Bill merged dip, head merged dip and neck merged dip were also adopted. Up-ending and circling were also observed very rarely in foraging group.

In the analyses, feeding guilds of waterbirds are defined on the basis of information on the feeding style and sensory mechanism.

Fish found in the bird habitat were studied by using fishing net. Fish catch per attempts were applied to study the abundance and it was not presumed for *ad hoc* reasons.

Diet of young Spot-billed Pelican was studied from regurgitated food samples which were collected from below the nesting trees at the school zone adjacent to the bird habitat. Recently-fed Pelican chicks regurgitate their food if disturbed (Findholt & Anderson 1995; Hatzilacou 1996). The fire-wood collectors and sheep-herders when entered the accessible nesting sites caused disturbance to the nesting birds; this opportunity was used to collect the fallen regurgitate food material which was placed in a transparent plastic bag. Five such visits (4 occurred during 23rd to 25th February and one on 11th March 2010) yielded 72 food samples. The species were identified directly. Gut analysis was not carried out as no bird was sacrificed for this purpose. The prey species from regurgitate samples were identified and individually enumerated. The weight and length of each item were noted with the help of a Pesola balance and metric scale. The collected food samples were from 65 to 90 days old chicks. The samples were grouped into two rearing periods according to the stage of the chicks, earlier period (samples collected from 65 to 80 days old chicks) and later (samples collected from above 80 days old chicks).

Diet was studied for relative frequency by numbers (RFN), relative frequency of occurrence (RFO), and relative frequency by weight (RFW) of each prey species as follows:

$$\text{Relative frequency of numbers (RFN)} = \frac{\text{No. of individuals of a species}}{\text{Total no. of individuals of all the species}} \times 100$$

$$\text{Relative frequency of weight (RFW)} = \frac{\text{Weight of a species}}{\text{Total weight of all the species}} \times 100$$

$$\text{Relative frequency of occurrence (RFO)} = \frac{\text{No of samples in which the species occurs}}{\text{Total no. of samples}} \times 100$$

By calculating Index of Relative Importance (IRI) adopted by Findholt and Anderson (1995) each prey species were ranked. (IRI = (RFN + RFW) x RFO/200). The value of the IRI ranges from 0, when all three values are 0%, to 100 when all three values are 100%.

Prey size variation along the chick development period was tested by using Mann-Whitney U test

Activity budget

Scan sampling method (Altmann 1974) was adopted to study the cluster of 2 to 27 nest birds and spent 144 hours in 2008 and 120 hours in 2009. In each observation period, time of day, weather condition, and the reproductive stage of each nest based on nest contents were recorded. If chicks were present, the number and stage of chicks were recorded. Totally 2493 records over 144 hours of observation times spread across a total of 12 days in 2008-09 and 2388 records over 120 hours of observation spread across 10 days in 2009-10 were obtained. Data was collected twice a month from October 2007 to March 2010 covering all the breeding activities (i.e. Display to fledgling stage) in nesting habitat and open water. Two alternate days were utilized to cover 12 hours in four time blocks viz., morning (0600-0900 h), late morning (0900-1200 h), midday (1200-1500 h) and late evening (1500-1800 h).

Focal animal sampling method was used for intensive observations (Altmann 1974; Altmann & Altmann 2003). In 2007, eight focal nests were selected and observed from nest initiation to fledgling. If focal nests were deserted, nests at the same stages were concentrated. Observations

were conducted on days without rain and strong winds. The focal nest was observed with spotting scope (Nikon 20x60) continuously for 15 minutes followed by a 5-minutes break. In one hour three such samples were taken. The duration of each behaviour/activity was recorded using an electronic stopwatch.

Totally 74 hours were spent to study the activity by using focal animal sampling method. Observation was plotted according to the nesting chronology.

In order to determine the frequency of occurrence of short-duration behavioural events, I carried out continuous 5-minutes focal animal sampling on the chosen individual alternately with the instantaneous sampling (Altmann 1974). During each of these observation periods, I collected data on all occurrences such as arrival with nest material, feeding chick, pecking, and nest maintenance, exhibited by the Spot-billed Pelican. These behaviours could also be considered as behavioural events as they often occurred in very short bouts throughout the day. The scan intervals reported in these studies ranged between 1-15 min. The 5-min interval between records was judged to be sufficient to ensure the independence of samples as followed by Maccarone *et al.* (2010). Adult activities were divided into sitting, standing, preening, feeding chicks, nest maintenance and time away from the nest.

Time spent in different activities in different stages was calculated and from these values the percentage time spent for each activity during different times on the day was estimated. The activities were divided into six major categories:

(i) Domestic chore: Nest making; incubating; nest maintenance; collection of nest material from open water, old nest and from ground; arrival with nesting material.

(ii) Social activity: Lek, bill clap, courtship display, flight-circuit, head swing, mating, defending nest material and pair, pecking, threatening, nest relief, interaction with other species.

(iii) Feeding : Feeding in water

(iv) Feeding chick

(v) Movement: Locomotion in water and soaring.

(vi) Maintenance: Preening, comfort movements, shaking, yawning, wing flapping and bathing.

(vii) Resting: Perched sleeping by placing head on back, head retracted back and eyes closed.

Here, resting was merged with the domestic chore for nesting birds as it was observed that incubating and (brood) guarding bird perched on the nest or near to nest and was considered as domestic chore. To compare the proportion of time spent in each activity as determined from scan samples, each activity is aggregated throughout each observation of the day. The proportion of scores in a given activity represented by the time individuals actually engaged in that activity. Statistical analyses were conducted on proportions (Squires & Anderson 1997) and reported in percentage by adopting Mendiratta *et al.* (2009).

The percentage time spent on each activity was estimated for each day as

$$T_a = 1/S \sum_{i=1}^{s} n_{ai}/N_i \times 100$$

Where, T_a = Percentage time spent on activity ''a'' per day,

S = Total number of scans in a day,

'n_{ai}' = Number of records of activity ''a'' in the i^{th} scan, and

'Ni' = Total number of records in the i^{th} scan.

I estimated the percentage time spent on activity "a" in all the months as

$$1/DTa,$$

Where, D is number of days (Mendiratta *et al.* 2009).

Data analysis

To analyze the data on the diurnal and seasonal patterns the breeding cycle of the Spot-billed Pelican was divided as follows: incubation period (weeks 1-4), pre-flight nestling stage (weeks 5-12), fledged stage (weeks 13-16) and post-flight stage (weeks 18-21) in the time-activity budget and frequencies of behavioural events in the Spot-billed Pelican.

As mentioned earlier, I calculated the mean frequencies per five minutes, of arrival with nest material, feeding chick, pecking, and nest maintenance using focal animal sampling.

To examine the diurnal variation of these behaviours across seasons, month-wise comparisons were carried out from September to March in two years, 2008-2009 and 2009-2010 of the study. I combined the six sampling months into four seasons, post south-west monsoon (September), north-east monsoon (October to December), winter (January to February) and summer (March to May).

Further, I classified the day into four time intervals (I = 0600-0900 hours, II = 0900-1200 hours, III = 1200-1500 hours, IV = 1500-1800 hours). For significance testing, comparison of each activity between years was made (years, seasons and time blocks pooled), Kruskal-Wallis test and one-way ANOVA were performed to compare activities between time blocks (year, seasons pooled) and stages overall, and using t-test difference in behaviours were studied separately. All the analyses are performed using SPSS 11 and SPSS 16 statistical software.

RESULT AND DISCUSSION

Breeding population and status

The status and colony size of the Spot-billed Pelican were studied in Andhra Pradesh. Nest surveys were carried out in Uppalapadu, Ramachandrapalayam, Nelapattu and Telineelapuram. Bird count and habitat use studies were done at Kolleru, Naupada Swamp and Kakarapally Creek, and Nelapattu, the three foraging sites.

Recent population trends indicate increasing breeding population of the Spot-billed Pelican. Highest number of nests was recorded at Uppalapadu (831±126) followed by Nelapattu (470±127) in 2007and the lowest number of nests (55.50 ± 50.20) was recorded at Telineelapuram. A new breeding colony of the Spot-billed Pelican was found in Ramachandrapalayam near Uppalapadu colony which accommodated 120±30 nests. The maximum estimated size in 4-5 breeding sites was 1476 ± 333.88 in 2007. Comparatively less colony size was estimated in 2008 and 2009 as 1015.5± 618.01 and 1139±527.49 respectively.

Colony size dynamics was studied with the help of colony size and duration of presence. Occupancy rate of a colony was positively related to colony size (logistic regression, $F = 0.380$, df= 3, $P < 0.001$; R^2=160) among the breeding sites studied. The Spot-billed Pelican population changed with changes in high quality habitat and broader ranges of habitat with stable local dynamics were used based on availability.

Colony size and location variability were assessed by the colony turnover rate (ti), the highest CV was for Ramachandrapalayam (103%) followed by Nelapattu (36%). Telineelapuram and Uppalapadu showed less stability 21 % and 28% respectively.

Occurrence of this Pelican in non-breeding sites along with habitat type was studied. Probably, increased water level and intense aquaculture practices were not preferred by this species (Fig. 6). In Naupada swamp and Kakarapally Creek 53% was observed in 2 marsh area during 2007-08 and was not recorded in the subsequent years (2008-09 to 2009-10) of study. In Kolleru, Spot-billed Pelican mostly used site with trees in all years while fish tanks were not preferred in 2008 and 2009. In Pulicat lake the Spot-billed Pelican used shallow water than mud flat.

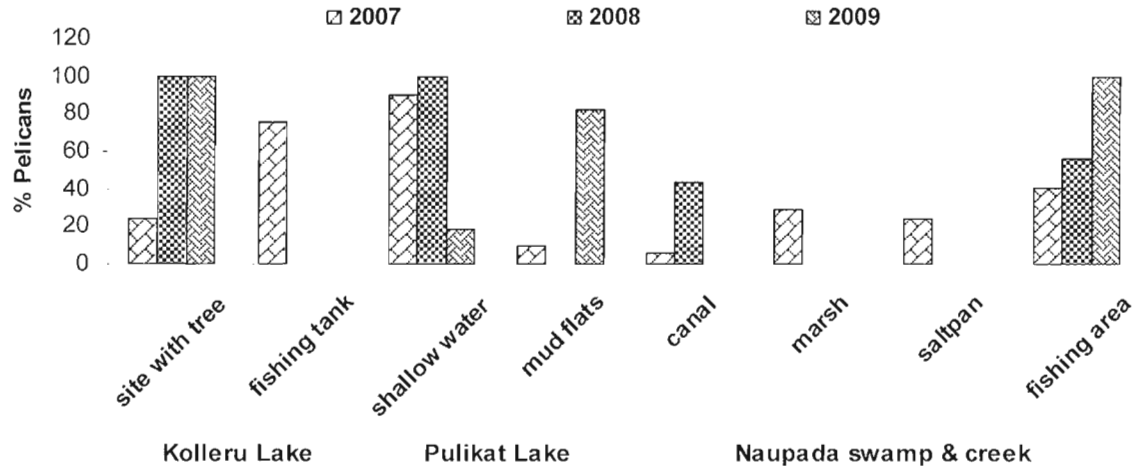

Fig. 6. Percentage of Spot-billed Pelicans observed in different habitats during ground surveys at three foraging sites from 2007 to 2009.

In Naupada swamp and creek the Spot-billed Pelican was found associated with fishing area and more frequently in marsh during 2007 and to some extent in canal in 2008. Demographic parameters such as annual productivity and population growth rate can be used to compare habitat quality among species and habitats for purposes of evaluating management plans.

Nest-site selection and breeding success

To understand the habitat requirements and factors determining habitat selection, evaluation of breeding performance, distribution of the colony and adaptations were studied. Nest placement in 2008 and 2009 showed maximum use of the height of 1 – 3 m. Early arrivers preferred nesting in higher trees while late nesters used comparatively lower tree heights. Tree variables such as tree height and tree DBH were recorded for 36 nest trees and 17 non-nesting trees and analysis showed significant variations in the tree height ($t_{0.74}$= 3.466, df=72, $p<0.001$) and DBH ($t_{2.03}$=4.968, df=72, $p<0.001$). Stepwise multiple regression procedures delineated tree height, distance from path and DBH as important factors that influenced most the nest-site selection of the Spot-billed Pelican in Uppalapadu.

According to accessibility, nests were studied randomly. A sample of 619 nests (180 in 2007, 246 in 2008 and 193 in 2009) was used for the analysis of nest-site characteristics, nest-site selection (Venkatraman 2007) and breeding success. Index of selectivity test (Ivlev 1961) was used to evaluate preference or avoidance of various tree species as nesting sites by following the formula: PI= U-A/ U+A. Preference test for nesting tree showed preference for the two nesting

tree species, namely *P. juliflora* and *P. dulce* (Ivlev's index). More nests were located in the patches with abundant *P. juliflora.*

The Pelicans bred asynchronously, showing a marked tri model pattern in each year i.e. In 2007-08 the peak number of nests was observed in the 4th week of September, second peak in the 4th week of November and 3rd peak in mid February. Delayed reproductive readiness limits nest-site selection to marginal nesting areas. The nests 3 are contiguous and formed clusters or sub-units ranging from 2 to 25 nests. Widely observed nesting unit of 6-10 accounted for 44%, 39% and 57% of all the units counted during 2007-08, 2008-09 and 2009-10 respectively.

Spot-billed Pelican chicks took 10 to 11 weeks to fledge. During 2007-08, 2008-09 and 2009-10, the annual productivity (fledged chick per nest) was 1.85± 1.18(0.86-2.33), 1.76 ±0.49 (1.00-3.00), 1.62 ± 0.77 (0.00-3.43) respectively. Multiple stepwise regression analysis showed that tree height, tree density, nest height, tree DBH and rainfall had significant influence on breeding performance of the Spot-billed Pelican. In the resulting model three independent variables, tree height, nest height and DBH had significant effect on breeding success ($F_{1,17}$ =1.57, P<0 .281) during 2007-08, but it explained only 69% of the variation. Nest height and DBH correlated highly with breeding success. In 2008-09, ($F_{1, 18}$=2.85, P<0.075), nest height, DBH and tree height explained 78% of the variation while during 2009-10, ($F_{1,17}$=1.57, P<0.051) above mentioned variables explained 84% of the variation showing their significance in determining breeding success.

Foraging behaviour and diet of chick

All feeding birds at observation sites were studied for the flock size and feeding technique. Two and more than two birds foraging at synchronized directional movements was treated as a socially foraging flock as followed by Battley *et al.* (2003). Totally in 89 events 1321 individuals were observed feeding. Distinctive feeding behaviour observed in social flocks was listed. The Spot-billed Pelican adopted bill merged feeding and mean flock size was 6.30±4.52. Scatter feeding is the second most used method and more individuals were observed 18.55±27.02 using this. Most adapted method by large number of birds as follows with number of individuals in each foraging groups. 357 individuals found using bill merged feeding (35.70±20.79); 124 individuals with neck straightening (11.27±16.17); 371 individuals with scatter feeding groups (18.55±27.02) and 359 in feeding groups of 17.95±23.31.

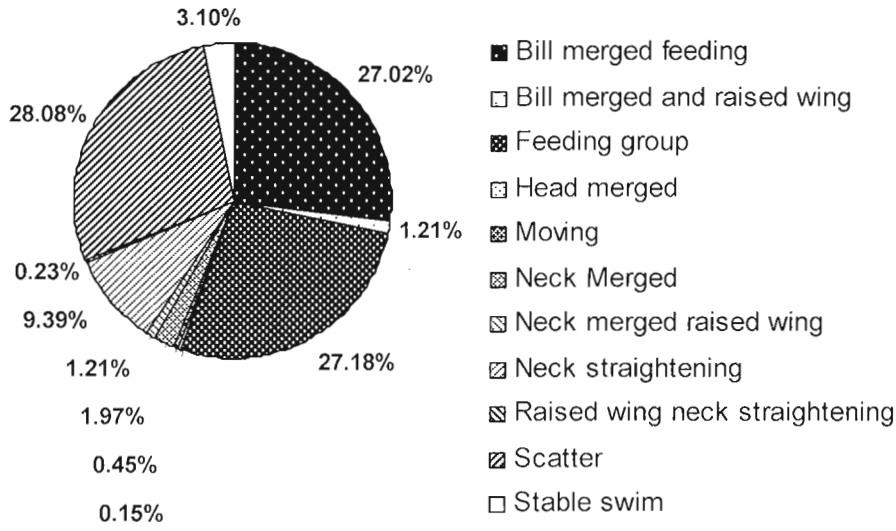

Fig. 7. Feeding methods observed in the Spot-billed Pelican

Diet of the Spot-billed Pelican was studied from regurgitated food samples which were collected from below the nests. The prey species from regurgitate samples were identified and individually enumerated. The weight and length of each item 4 were noted with the help of a Pesola balance and metric scale. The collected food samples were from 65 to 90 days old chicks. The samples were grouped into two rearing periods according to the stage of the chicks, earlier period (samples collected from 65 to 80 days old chicks) and later (samples collected from above 80 days old chicks).

Diet was studied for relative frequency by numbers (RFN), relative frequency of occurrence (RFO), and relative frequency by weight (RFW) of each prey species. Identification of prey items was done from samples collected in February (n=63) and March (n=9). Totally 72 fishes were identified representing four species, namely *Oreochromis mossambicus, Cirrhinus mrigala, Puntius dorsalis* and *Labeo rohita. Oreochromis mossambicus* occurred in higher frequency 83% to 56 % in the two rearing periods respectively and lower frequency of 5 % was of *Puntius dorsalis* in earlier rearing period. Considering all the above frequency values IRI was calculated for all prey species and found that *Oreochromis mossambicus* (70.52), *Cirrhinus mrigala* (8.76) *and Puntius dorsalis* (1.07) were the most important prey in the earlier period, whereas *Labeo rohita* (70) had the highest IRI value followed by *Oreochromis mossambicus* (15) in the later period.

Size class distribution of food of the Spot-billed Pelican among early and later periods showed significant variation from each other ($p<0.05$); length size varied between the two different rearing periods ($U=95$, $df=71$, $p<0.01$), so also width ($U=79$, $df=71$, $p<0.01$) and weight ($U=82$, $df=71$, $p<0.01$).

Activity

Totally 2493 records of activities of the Spot-billed Pelican over 144 hours of observation spread across a total of 12 days in 2008-09 and 2388 records over 120 hours of observation in 10 days in 2009-10 were obtained. I carried out continuous 5-minutes focal animal sampling on the chosen individual alternately with the instantaneous sampling (Altmann 1974). The activities were divided into six major categories such as domestic chore, social activity, feeding, feeding chick, movement, maintenance and resting.

To compare the proportion of time spent in each activity as determined from scan samples, each activity was aggregated for observation of one day. The proportion of scores in a given activity represented the time individuals actually engaged in above grouped activity. Statistical analyses were conducted on proportions (Squires & Anderson 1997) and reported in percentage by adapting Mendiratta *et al.* (2009).

The Spot-billed Pelican spent maximum time on domestic chore (43.37%) followed by maintenance (18.13%) and display (6.45%). The time spent on both domestic chore and maintenance varied significantly between the years ($t=-3.51$, $p<0.01$; $t=-2.26$, $P<0.05$ respectively). However, for display no marked difference was found ($t=0.85$, $p>0.05$). In Post South-west monsoon the Pelican arrived at the breeding ground. The domestic chores was high (41.10%) followed by maintenance (23.07%). Among the grouped seasons post south-west monsoon showed high display activity (21.90%), but it was low in north-east monsoon, winter and summer. Comparison of time spent across seasons in various activities by the Spot-billed Pelican showed significant variation. Maintenance was the major activity throughout the day for the adult. It was higher in the morning (20.27%) than during midday (13.27%) and the activity across the time blocks varied significantly ($\chi^2=20.215$, $df=3$, $p=0.000$). Feeding chick varied significantly among time blocks ($\chi^2=25.413$, $df=3$, $p=0.000$). The young Spot-billed Pelican spent most of the time for resting (16.62%) followed by maintenance (4.32%). Feeding was very less in afternoon (2.71%). Time spent on various activities such as resting, maintenance, social, movement and feeding did not vary significantly across the 4 time blocks (resting $\chi^2=6.090$,

df=3, p=0.107; maintenance χ^2 =4.567, df=3,p=0.206; social χ^2 =0.189, df=3, p=0.979; movement χ^2 =4.137, df=3, p=0,247; feeding χ^2 =0.331, df=3, p=0.954).

In adult significant variation was found in following activities, namely domestic chore χ^2=18.199, df=11, p=0.000, movement χ^2=24.215, df=11, p=0.000 and feeding χ^2=39.097, df=11, p=0.000 and in young one resting, maintenance, social, movement and feeding showed marked difference among the hours of the day.

INTRODUCTION TO CURRENT PROFORMA

In South India, population of *Pelecanus philippensis* had declined considerably in the recent past and a few recommendations have been given for its conservation, improving the nesting habitat of this species (BirdLife International 2010). Generalized recommendations for the conservation of water birds in natural and created wetlands have been elusive because studies are often of a local nature, and do not compare source data against those from other regions.

In this study geographically broad habitat relationships of the Spot-billed Pelican were examined to provide conservation prescriptions in four different sites in villages with huge nesting trees, irrigation tank or seasonal tanks with clumps of nesting trees. We develop models from our study in Uppalapadu, Telineelapuram, Nelapattu and Ramachandrapalayam. Numbers of breeding Spot-billed Pelican have dramatically increased in Andhra Pradesh, and the population may currently be restricted by breeding habitat. Safer nesting sites and readily available food during breeding season was linked to increased or strong site tenacity in traditional or newly emerged nesting sites and increased occupancy rate and abundance of the Spot-billed Pelican in colony sites. It is found that the Spot-billed Pelican prefers to nest in fishing tanks. So protection of this species at the private fish tanks and protection of nesting trees should be provided as they were uprooted by the pond owners. Providing artificial tree structure is easily adapted by the nesting Pelican in Uppalapadu but not utilized in the Kolleru and Nelapattu (fig p & q). The nesting association with the Painted Stork is observed in Telineelapuram but not in Nelapattu sanctuary as they nest with Asian Openbills. In Uppalapadu, though the nesting association was correlated with nesting Painted Stork the decreasing population of Painted Stork had less effect on nesting Spot-billed Pelican. Several other species such as Asian Openbill and Painted Stork used the artificial structure for nesting. The management activity such as planting sapling, placing tree guards, manual removal of *Eichhornia* and providing artificial nesting substrate and of changes in water regime were listed chronologically with birds breeding activity and provided recommendations, such as any above listed activity should be done in non-breeding season when the nesting activities are less and net conservation benefit can be realized from management action.

Major threats for the Spot-billed Pelican population of Uppalapadu that stem from the breeding site (Sheeba & Vijayan 2009a) can be listed as:

(i) Nest disturbance by inhabitants or visitors (of nests on the outer fences and school building top in particular)

(ii) Nest deserted due to intrusion made by cleaning the pond or other management activity of planting saplings, mound strengthening, and removing water from the reservoir for management purpose.

(iii) Pollution of nearby wetlands and cultivable field by the pesticide use and by fish feed (although no negative effects were detected on breeding success a reduction in water quality is probable in the near future).

(iv) Intrusion by photographers and visitors.

(v) Hunting pressure and illegal fishing in and around bird habitat.

(vi) Pollution by bird excreta and their consequence such as foul smell.

Management suggestions

- Area adjacent to the bird reserve (maximum possible, at least 15 acres) may be acquired and added to the existing reserve and, protected and managed as a Community Reserve/ Conservation Area. Management actions may be taken keeping the following points in consideration:

  (i) The nesting area should be inaccessible to mammalian predators and free of disturbance from humans, i.e., firewood collection in the fringe area.

  (ii) Nesting trees species, namely *Barringtonia sp., Acacia nilotica, Pithecellobium dulce, Borassus flabellifer* on the mounds and bunds.

  (iii) Some mounds without vegetation will facilitate resting of the fledged young and non- nesting birds.

  (iv) Artificial nesting trees may be erected for immediate use by the Pelicans.

  (v) Provide large open water area for feeding of pelicans and other birds.

  (vi) Periodic replenishing of fish with fingerlings.

  (vii) Have a combination of surface vegetation to provide extra habitat to attract other waterbird species such as wintering and resident ducks.

- Minimize disturbance level in school zone by renovating the barbed fences.
- Strengthening the villagers' support through education and awareness programmes.
- Eco-development programmes including eco-tourism with trained guides from the nearby villages.

- Stopping and even reversing attempts to drain wetlands to straighten the mounds or construction work inside bird habitat should be limited and monitoring the water quality in the future.
- Making local villagers more aware of the importance of the Spot-billed Pelican and the importance of the heronry for this species.
- Additional water supply to fulfill the need of the people who share the reservoir for birds.

Management suggestions for other sites

The increase in the number of nesting birds in survey areas resulted from a number of factors mainly suitable and safer nesting sites and nearby foraging sites as reported by Hafner *et al.* (1986). After three decades the nesting activity at Kolleru was restored by destroying fish farms from the Sanctuary area in 2005. The colony was not sustained because of the recreational activity such as boating. The new colony at Uppalapadu was mainly of the population from Kolleru. Shift in sub-colony formation was due to high disturbance at breeding site. Since colonies move, protection of colonies (outside protected area) and foraging sites should be encouraged to shelter more birds. A species' conservation concerns will differ within the species' range and we should develop and implement a conservation programme based on a thorough understanding of the population dynamics, including size and trend and how survival and mortality constrain population stability (Kushlan 1992).

So, we recommend the conservation needs as given below (Sheeba & Vijayan 2009b):

- Kolleru: Restricting recreational activity at nesting sites and protection from poaching and contamination from fishery industries.
- Uppalapadu: Management activity should be done in non-breeding season without interrupting the habitat quality.
- Telineelapuram: Protection through community participation.
- Ramachandrapalayam: Protection of nesting trees through community participation.
- Nelapattu: Retain the water levels during breeding season.

Conservation needs and conclusion

The management of ecosystems rather than individual species is taking a forward position in environmental conservation (Kushlan 1993). Active management will probably need to include: protection and active manipulation of colony sites; protection, active manipulation, and even restoration of feeding habitat, and protection and active management of wintering sites. The ideal

management plan would involve meeting the habitat needs of all cohabiting colonial wading bird species over an area sufficiently large to encompass the biological limits of each population. This process requires regional approaches to colony and habitat management. Wetland management should be designed to meet seasonal needs for a diversity of waterbird species that may use these restored habitats (Kaminski *et al.* 2006).

Understanding the potential of and constraints on such regionally-based conservation planning is an important area of research (Kushlan 1992). Decisions on the timing, frequency, duration and magnitude of environmental water allocations depend on sound knowledge of ecological thresholds, and indicators to measure success or failure of management interventions (Jenkins *et al.* 2009). As suggested by Klein (1993) visitors' attitudes especially school children were enhanced by effective nature education programmes such as bird- watching, explaining life history strategies of water birds.

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Appendix 1: List of waterbirds observed at Uppalapadu

Order	*Scientific name*	English name	Telugu name	Status
Podicipediformes	*Tachybaptus ruficollis*	Little Grebe	Munu-gudi-kodi	R
Pelecaniformes	*Pelecanus onocrotalus**	Great White Pelican	Chinkabatu	R
Pelecaniformes	*Pelecanus philippensis*	Spot-billed Pelican	Chinkabatu	LM
Pelecaniformes	*Phalacrocorax niger*	Little Cormorant	Neetikaki	R
Pelecaniformes	*Phalacrocorax fuscicollis*	Indian Cormorant		R
Pelecaniformes	*Phalacrocorax carbo**	Great Cormorant	Bontakaki	R
Pelecaniformes	*Anhinga melanogaster*	Darter	Pamubatu	R
Ciconiiformes	*Ardea cinerea*	Grey Heron	Narayana pachchi	R
Ciconiiformes	*Ardea purpurea*	Purple Heron	Yerra narayana pakshi	R LM
Ciconiiformes	*Casmerodius albus*	Great Egret	Pedda tella konga	R LM
Ciconiiformes	*Mesophoyx intermedia*	Intermediate Egret	Tella konga	R LM
Ciconiiformes	*Egretta garzetta*	Little Egret	Chinna tella konga	R LM
Ciconiiformes	*Ardeola grayii*	Indian Pond Heron	Guddi konga	R LM
Ciconiiformes	*Butorides striatus*	Little Heron	Dosi konga	R
Ciconiiformes	*Bubulcus ibis*	Cattle Egret	Samti konga	R
Ciconiiformes	*Nycticorax nycticorax*	Black-crowned Night Heron	Chinta wakha	R LM
Ciconiiformes	*Ixobrychus sinensis*	Yellow Bittern		R LM
Ciconiiformes	*Ixobrychus cinnamomeus*	Cinnamon Bittern		R LM
Ciconiiformes	*Mycteria leucocephala*	Painted Stork	Yeru kala konga	R LM
Ciconiiformes	*Anastomus oscitans*	Asian Openbill	Galu konga	R LM
Ciconiiformes	*Ciconia episcopus***	Woolly-necked Stork		R V

Ciconiiformes	*Leptoptilos javanicus***	Lesser Adjutant		R V
Ciconiiformes	*Threskiornis melanocephalus*	Black-headed Ibis		R LM
Ciconiiformes	*Plegadis falcinellus*	Glossy Ibis	That kankanam	R LM
Anseriformes	*Sarkidiornis melanotos*	Comb Duck	Juttu chiluwa	R LM
Anseriformes	*Anas crecca*	Common Teal		WV
Anseriformes	*Anas poecilorhyncha*	Spot-billed Duck		R OM
Anseriformes	*Anas acuta*	Northern Pintail		WV
Anseriformes	*Anas querquedula*	Garganey		WV
Anseriformes	*Anas clypeata*	Northern Shoveler		WV
Anseriformes	*Rhodonessa rufina**	Red-crested Pochard		WV
Anseriformes	*Aythya ferina*	Common Pochard		WV
Gruiformes	*Amaurornis phoenicurus*	White-breasted Waterhen	Buda kodi	R
Gruiformes	*Porphyrio porphyrio*	Purple Swamphen	Nila bolli kodi	R LM
Gruiformes	*Gallinula chloropus*	Common Moorhen	Jumbu kodi, Bolli kodi	R PWV
Gruiformes	*Fulica atra*	Common Coot	Bolli kodi	R WV
Charadriiformes	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana		R LM
Charadriiformes	*Metopidius indicus*	Bronze-winged Jacana		R
Charadriiformes	*Gallinago gallinago*	Common Snipe	Muku puredi	PR WV
Charadriiformes	*Himantopus himantopus*	Black-winged Stilt		R LM
Charadriiformes	*Vanellus indicus*	Red-wattled Lapwing	Yennapa chitawa	R
Charadriiformes	*Tringa glareola*	Wood Sandpiper	Chinna ulanka	WV
Charadriiformes	*Actitis hypoleucos*	Common Sandpiper	Polte ulanka	WV
Charadriiformes	*Calidris temminckii*	Temminck's Stint		WV
Coraciiformes	*Halcyon smyrnensis*	White-throated Kingfisher		R
Coraciiformes	*Alcedo atthis*	Small Blue Kingfisher		R
Coraciiformes	*Ceryle rudis*	Pied Kingfisher		R

Appendix II: Other species of birds observed at Uppalapadu

Order	*Scientific name*	English name	Telugu name	Status
Coraciiformes	*Upupa epops*	Common Hoopoe		R LM
Piciformes	*Dinopium benghalense*	Black-rumped Flameback		R
Falconiformes	*Circus aeruginosus*	Eurasian Marsh Harrier		WV
Falconiformes	*Accipiter badius*	Shikra		R
Falconiformes	*Ictinaetus malayensis*	Black Eagle	Adavi nalla gadda	WV
Psittaciformes	*Psittacula krameri*	Rose-ringed Parakeet	Chiluka	R
Cuculiformes	*Clamator jacobinus*	Pied Cuckoo		R
Cuculiformes	*Surniculus lugubris*	Drongo Cuckoo		BV
Cuculiformes	*Eudynamys scolopacea*	Asian Koel	Nalla kovela(M), Poda kovela (F)	R LM
Cuculiformes	*Centropus bengalensis*	Lesser Coucal		R
Coraciiformes	*Coracias benghalensis*	Indian Roller	Pala pitta	R LM
Passeriformes	*Oriolus oriolus*	Eurasian Golden Oriole	Vanga pandu	V
Passeriformes	*Dicrurus macrocercus*	Black Drongo	Passala poli gaud	R LM
Passeriformes	*Terpsiphone paradise*	Asian Paradise-Flycatcher	Toka pigilipitta	R LM
Passeriformes	*Corvus splendens*	House Crow	Manchi kaki	R
Passeriformes	*Hirundo rustica*	Barn Swallow	Wana kovela	R
Passeriformes	*Hirundo daurica*	Red-rumped Swallow		WV
Passeriformes	*Prinia inornata*	Plain Prinia	Lota-kun-jitta	R
Passeriformes	*Pycnonotus cafer*	Red-vented Bulbul	Pigli-pitta	R
Passeriformes	*Orthotomus sutorius*	Common Tailorbird	Likka jitta	R
Passeriformes	*Acridotheres tristis*	Common Myna	Goranka	R

	Sturnus pagodarum	Brahminy Starling	Papata gorinki	R LM
Passeriformes	*Sturnus roseus*	Rosy Starling	Pariki pitta/Palisa	WV
Passeriformes	*Sturnus contra*	Asian Pied Starling	Venda gorinka	R LM
Passeriformes	*Nectarinia zeylonica*	Purple-rumped Sunbird		R
Passeriformes	*Nectarinia asiatica*	Purple-Sunbird	Thena-pitta	R LM
Passeriformes	*Ploceus philippinus*	Baya Weaver	*Parsupu pitta*	R
Passeriformes	*Motacilla maderaspatensis*	White-browed Wagtail	Sakala sarela-gadu	R
Passeriformes	*Motacilla flava*	Yellow Wagtail		WV

* Occasional visitors; R-Resident; LM-Local Migrant; V-Vagrant; WV-Winter Visitor;
** *Rare Visitors* ; PR-Partially Resident

Plate 1

NESTING HABITAT CHARACTERISTIC

Nesting in *Barringtonia* sp (Nelapattu)

Nesting in *Prosopis juliflora* (Uppalapadu)

Nesting in *Tamarindus indica* (Telineelapuram)

Birds at *Borassus flabellifer* (Kolleru)

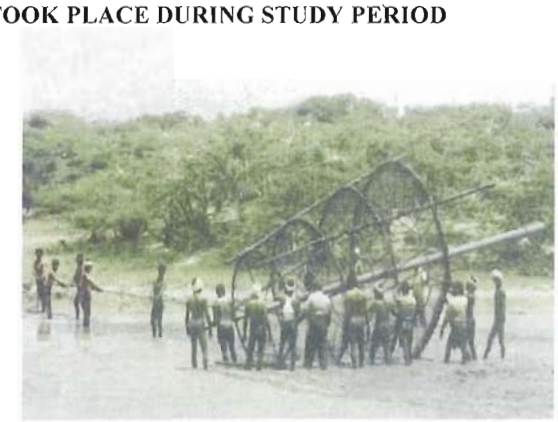
Ground nesting by the Spot-billed Pelican

Sub-canopy nest by the Spot-billed Pelican

Plate 2

CHIEF MANAGEMENT ACTIVITIES TOOK PLACE DURING STUDY PERIOD

a. Connecting road was established from main road to the Bird protected habitat



b. Planting artificial nesting tree (iron) in 2008

c. Revetment of mounds by stone

d. Railing along the bund

e. Watch tower and sheds for visitors

f. Reconstruction of the entrance

Plate 3

DISTURBANCES OBSERVED AT UPPALAPADU

g. Disturbance by stray dogs and monkey

h. Egg predation by crow

i. Recreational activity

j Intrusion by photographers

k. Cattle grazing

Plate 4

EDUCATION PROGRAMMES ORGANIZED AT UPPALAPADU

l. Strengthening community participation

m. DFO is explaining to foreign visitors

n. World Wetland Day 2009 Conducted by SACON

o. World wetland day Celebration in 2010 (Talk by DFO. Guntur)

MANAGEMENT IMPLICATION IN OTHER PLACES

p. Artificial nesting tree (iron) at Kolleru

q. Wooden nesting platform at Nelapattu