

SHORT COMMUNICATION

DIET PREFERENCE AND ACTIVITY PATTERNS OF GREAT WHITE PELICANS (*PELECANUS ONOCROTALUS*, LINNAEUS, 1758) AT LAKE HAWASSA, ETHIOPIA

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ABSTRACT: A study on the diet preference and activities of Great White Pelicans (*Pelecanus onocrotalus*, Linnaeus, 1758) was carried out along the shore of Lake Hawassa, Ethiopia, during the wet and dry seasons in 2011/2012. Repeated observations and focal animal sampling methods were used to study the diet and activity patterns. Activity patterns including feeding, resting, preening, flying and alert behaviour were analyzed. Great White Pelicans feed primarily on fish (81.9%), they also feed on worms (13.1%), amphibians (0.94%) and some other invertebrates (4.05%). The percentage frequency of fish in the diet of *P. onocrotalus* was 79.2% and 84.5% during the wet and dry seasons, respectively. Major activities of the species during the day time were feeding (45.69%), resting (23.39%), preening (13.95%), flying (14.7%) and alert (1.95%). Feeding activity was intensive and reached its peak in the morning (09:00-12:00 h) and late afternoon hours (15:00-18:00 h). Resting was more during the midday. Further ecological studies on Great White Pelicans should be conducted to get more information about the bird and facilitate conservation measures in the study area.

Key words/phrases: Activity patterns, Feeding ecology, Great White Pelicans, Lake Hawassa.

INTRODUCTION

Of the seven pelican species found worldwide, only the Great White Pelican (*P. onocrotalus*) and the Pink-backed Pelican (*P. rufescens*) are found in Africa (Hoyo *et al.*, 1992). Great White Pelicans (*Pelecanus onocrotalus*, Linnaeus, 1758) are large, conspicuous, white birds, easily seen and identified. The Pink-backed Pelican is generally greyer overall than the Great White Pelican. There is less contrast between the less black flight feathers and the rest of the body than in the Great White Pelican. The black smudge in front of the eye is also diagnostic in the field (Johnsgard, 1993). Males of *P. onocrotalus* are larger than females and have a long beak that

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grows in a downward arc, as opposed to the shorter, straighter beak of the female. Immature birds are grey and have dark flight feathers (Mclachlan and Liversidge, 1978). The Great White Pelican is well adapted for aquatic life. The short strong legs and four webbed toes propel it in water and aid the rather awkward takeoff from the water surface. The pelican's pouch is simply a scoop. As the pelican pushes its bill underwater, the lower bill bows out, creating a large pouch which fills with water and fish (Johnsgard, 1993). They feed on fish and aquatic organisms throughout their distribution range (Hoyo *et al.*, 1992; Sibley, 2000) in freshwater lakes, estuaries and shallow marine bays. They are largely piscivorous birds. They could be used as an indicator species for the fish dynamics of the lake at medium to low lake levels (Bowker and Downs, 2008b). Most use their large beaks and extensible pouches to capture fish in shallow waters. Their scoop-feeding method enables them to take wide range of prey size (Crivelli *et al.*, 1997). They are opportunistic feeders and scavengers, occasionally eating carcasses or waiting for scraps from fishermen. Intensive fishery and aquaculture sites become their favourite feeding places either during migration or in winter (King *et al.*, 2010; Treena *et al.*, 2011). For successful breeding, regular colonies must have an assured supply of fish. The adult daily food intake has been estimated to be 0.8-1.2 kg, about 10% of adult mass (Surai *et al.*, 2001). Cooperative hunting is commonly used by Great White Pelicans to capture fish (Saino *et al.*, 1994). Recently, cooperative hunting of seabird chicks by pelicans was observed on Dassen Island, targeting Cape Cormorants (*Phalacrocorax capensis*) and Kelp Gulls (*Larus dominicanus*) (Cloutier *et al.*, 2002; de Ponte Machado and Hofmeyr, 2004; de Ponte Machado, 2007; de Ponte Machado *et al.*, 2009).

Great White Pelicans are distributed across all continents except Antarctica (Crivelli *et al.*, 1991). They breed in Africa, Europe and Asia. The world's population is believed to be about 85, 000 pairs, of which about 80% are in Africa (Shmueli *et al.*, 2000a; Izhaki *et al.*, 2002; Bowker and Downs, 2008a). They are extremely mobile birds and cover great distances (Crawford, 2005). In Africa, *P. onocrotalus* is known to breed more or less regularly at Lake Shala, Ethiopia; Lake Rukwa, Tanzania; St. Lucia Bay, Natan; Abou Toumour, Chad; Kapsikis, northern Cameroon and Wase Rock, Nigeria (Berry *et al.*, 1973; Urban, 1984). Lake Shala in the Rift Valley is one of the most important sites for breeding colonies of the Great White Pelican in Africa, with an average of 6,000-8,000 nesting pairs per year (Brown and Urban, 1969). Today, this colony has only a few hundred pairs because their main feeding ground, Lake Abijata, has become saline and

most of the fish disappeared. Lake Shala is deep, with a low fish yield (Urban, 1984), thus, the main feeding lake of the breeding birds is the relative shallow Lake Abijata, but they also feed at Lakes Hawassa, Ziway, Langano, Koka, Tana, Abaya and Chamo (Brown and Urban, 1969).

The greatest threat to pelican population is disturbance at breeding colonies (Boellstorff *et al.*, 1988), habitat destruction, drainage of wetlands (King and Michot, 2002; Murphy, 2005; Bowker and Downs, 2008b) and competition with man for fish. Today, because of overfishing in certain areas, White Pelicans are forced to fly long distances to find food (Shmueli *et al.*, 2000a; Crawford, 2005); illegal shooting, collision with transmission lines, wires and fences (Shmueli *et al.*, 2000b) and pesticide contamination are other threats to the pelican populations (Anderson *et al.*, 1996).

Feeding ecology and activity patterns of Great White Pelicans and conservation problems in Ethiopia have not been studied in detail. Hence, the present study attempts to obtain information on the feeding ecology and activity patterns of Great White Pelicans around Lake Hawassa, in the Great East African Rift Valley.

METHODS

The study area

This study was carried out in Southern Nations, Nationalities and Peoples Regional State (SNNPRS) around Lake Hawassa (Fig. 1). Lake Hawassa is located around 275 km south of Addis Ababa in the western side of Hawassa town, and is the capital of Southern Nations, Nationalities and Peoples Regional State, in the Great East African Rift Valley. It lies at an altitude between 1,668 m from Tikur Wuha river to 1,682 m a.s.l at 'Amora Gedel' lake shore. The Hawassa lake watershed falls in between 6° 58'-7° 33' N latitude and 38° 22'-38° 29' E longitude. Lake Hawassa is topographically a closed basin, where there is no known outflow. This lake is primarily fed by Tikur Wuha river. It has a surface area of 90 km² (Makin *et al.*, 1975), a catchment area of 1,250 km², a maximum depth of 22 m with a mean depth of 11 m (Welcome, 1972). The littoral zone of the lake is covered by rooted and floating vegetation (*Tudorancea et al.*, 1988). The shore is mainly forested with indigenous species of trees such as *Acacia*, *Ficus glumosa* and *Ficus sycomorus*. The rainfall pattern of Hawassa area is characterized by bimodal distribution with short spring and long summer rainy seasons. The mean annual rainfall is 977.1 mm. During 1996-2012, the highest monthly rainfall recorded was 107.1 mm (April) and 127.1 mm

(September). The mean monthly temperature varied between 17°C and 22°C and the mean annual temperature of the study area is 19.5°C.

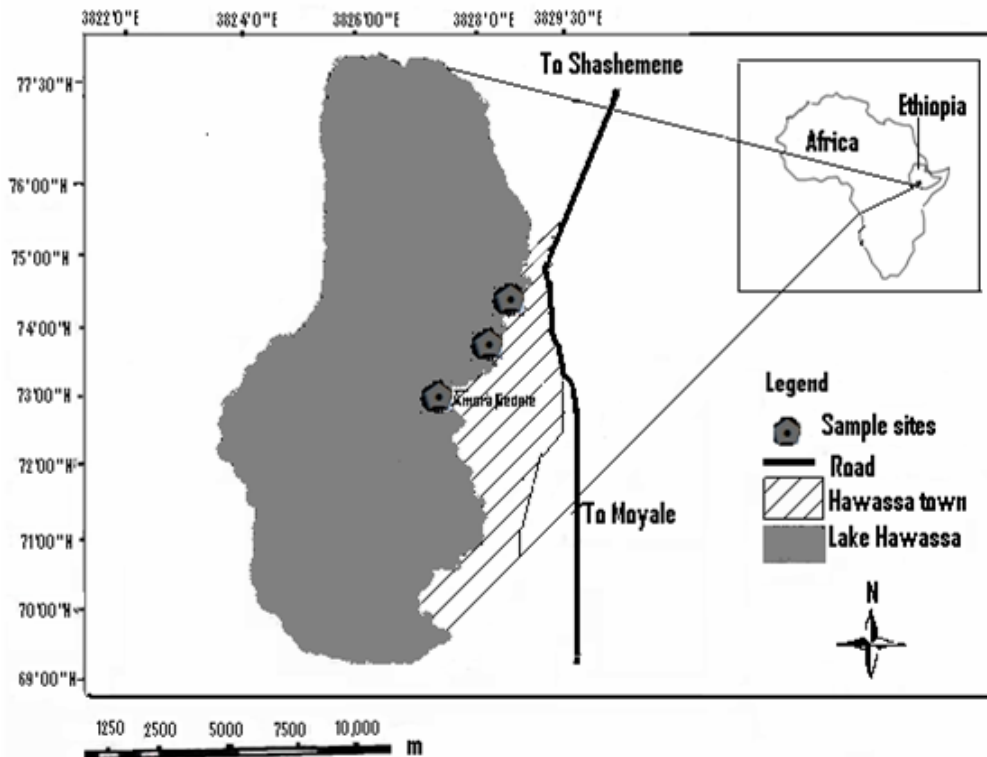


Fig. 1. Map of the study area showing the location of sample sites.

Methods

A pilot survey was conducted in November 2011 to gather information about the distribution, feeding behaviour and activities of Great White Pelicans around Lake Hawassa. Information was gathered from fishermen, tourist guides and other native individuals around the study area. Sample areas were randomly selected and data were collected during the dry season (December to February) and wet season (March to August), 2011/2012.

Diet composition

To collect data about the diet composition of the Great White Pelicans, repeated observations were carried out for 480 h during the wet and dry seasons. Observations were made with binoculars. Useful information can be obtained by observing when birds feed. Time spent on foraging was recorded using focal sampling methods following Sutherland *et al.* (2004).

Focal sampling consists of watching an individual for 10 minutes. If the focal bird in the field disappeared from view, the time interval of its disappearance was recorded. When the out of sight period was longer than the duration of common activities, it was deleted from the sample and duration of the sample period was reduced accordingly and another bird was selected, closest to the observer. A group or individual birds was followed from a distance of 5-10 m. Foraging behaviour was observed following the sampling methods used by Rodrigues *et al.* (1994). When a single individual or a pair or flock was seen feeding, it was considered as one observation. The type of food items was identified. Data were collected early in the morning from 06:00-10:00 h and late in the afternoon from 14:00-18:00 h, when most of the avian species were engaged in feeding activities (Buskirk and McDonald, 1995).

Activity patterns

Activity patterns of the Great White Pelican were observed using focal animal sampling method (Altman, 1974). Sampling was conducted on three randomly selected days per week with each day divided into equal time blocks. Activities during different hours of the day such as early morning (06:00-09:00 h), late morning (09:00-12:00 h), mid-day afternoon (12:00-15:00 h), and late evening (15:00-18:00 h) were observed. Each observation session started with the choice of a focal individual bird, by selecting the closest readily visible individual. If the bird was out of sight, another bird was selected, closest to the observer. The focal individual was observed with binoculars continuously for 15 minutes followed by a 5 minute break. The pattern of observation in each time block was as follows: in each one hour, there were three 15 minute continuous monitoring periods followed by a 5 minute break. The time spent in different activities was calculated and the percentage of time spent was estimated for each activity during different time blocks of the day. Observations were made with binoculars and the duration of each behaviour was recorded by using stop watch. The activities were divided into six major categories: (i) Search time: the time spent by birds in searching and handling prey, handling them into the mouth prior to swallowing, (ii) Resting: perched birds that were sleeping or dozing, with the head retracted and eyes closed, (iii) Preening: consisted of all forms of comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, body shaking and tail shaking, (iv) Flying: the time spent by birds in flight, very often in pursuit of prey, (v) Alert: birds perching in an upright position and scanning their surroundings actively.

Data analysis

Data were analyzed by using SPSS version 17 computer software programme (SPSS Inc, IL, USA) and Microsoft Excel.

RESULTS

Diet composition

Great White Pelicans feed primarily on fish, but they also feed on amphibians, worms and other invertebrates. Out of the total 480 h of feeding observations during the wet and dry seasons, the highest percentage frequency was on fish (81.9%), worms (13.1%), amphibians (0.94%) and other kinds of small invertebrates (4.1%) (which were difficult to identify). During the wet season, their diet consisted of fish (79.2%), worms (15.4%), amphibians (1.1%) and other invertebrates (4.2%). During the dry season, the percentage frequency was on fish (84.5%), worms (10.8%), amphibians (0.77%) and other invertebrates (3.9%) (Fig. 2). There was a significant difference in the frequency of taking different foods items during the wet season ($\chi^2=36.6$, $df=3$, $p<0.05$) and during dry season ($\chi^2=39.9$, $df=3$, $p<0.05$). However, there was no significant difference observed in the type of prey items consumed during the wet and dry seasons ($\chi^2=24.8$, $df=1$, $p>0.05$).

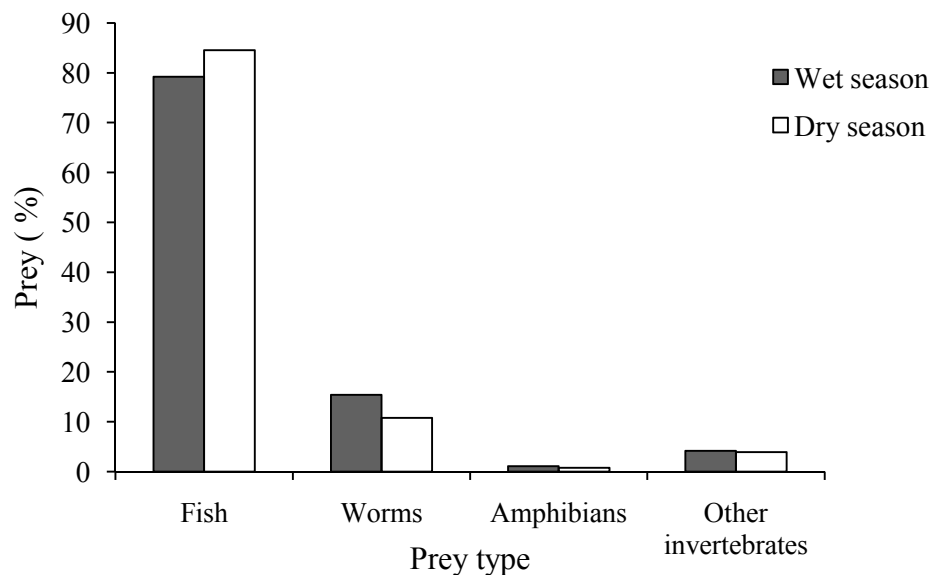


Fig. 2. Observed foraging frequency of Great White Pelicans on different prey items during the wet and dry seasons.

Diurnal activity patterns

A total of 504 h were spent observing Great White Pelicans perform various activities related to foraging. These activities show certain variations in frequency during the time of the day. The percentage frequencies of occurrence of diurnal activities of Great White Pelicans during the wet and dry seasons are given in Fig. 3. Among the various activities displayed by Great White Pelicans, feeding, resting, preening, flying and alerting were the major and common activities observed during both wet and dry seasons. Feeding and resting were the most predominant activities in both the wet and dry seasons. Out of the total 504 h of observations during the day time, feeding activities accounted for 45.69%, followed by resting (23.39%), preening (13.95%), flying (14.7%) and alert (1.95%). During the wet season, the largest proportion of the activity consisted of feeding (41.9%), whereas the remaining activities were resting (30%), preening (14.6%), flying (11.8%) and alert (1.3%). During the dry season, feeding also accounted for largest proportion of the activity (49.47%), followed by resting (16.8%), preening (13.3%), flying (17.6%) and alert (2.6%). They spent more time in feeding during the dry season than during the wet season. However, they devoted more time in resting during the wet season than during the dry season. There was a significant difference among the time spent in feeding and resting ($\chi^2=61.5$, $df=1$, $p<0.05$, $\chi^2=52$, $df=1$, $p<0.05$, respectively) between the wet and dry seasons.

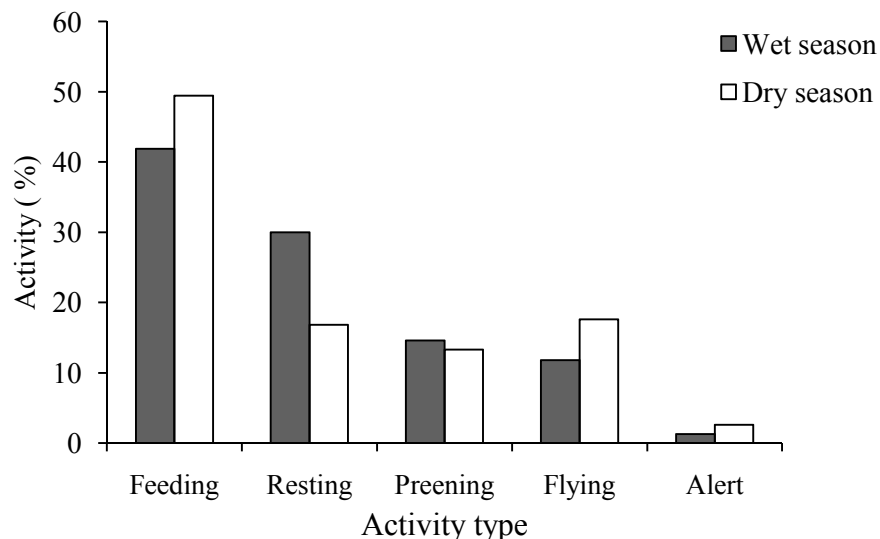


Fig. 3. Time spent on different activities by Great White Pelicans during wet and dry seasons.

Feeding activities varied among the time blocks. It was higher in the morning (56.36 ± 9.9) and evening (43.0 ± 7.63) than in mid-day (20.13 ± 3.8). Resting (28.87 ± 1.48) and preening (27.04 ± 4.26) were higher during mid-day. They used rocky lakesides during preening or resting. Flying was highest (16.46 ± 0.98) during the early morning and late evening (21.15 ± 3.44) hours. Alert behaviour comprised relatively minor proportions (Table 1). Time allocated to different activities varied significantly according to day light hours.

Table 1. Percentage of time spent (Mean \pm SD) by Great White Pelicans on different activity patterns in time block.

Activity patterns	Time of the day (time block) in hours			
	06:00-9:00 h	09:00-12:00 h	12:00-15:00 h	15:00-18:00 h
Feeding	47.5 \pm 2.47	56.36 \pm 9.9	20.13 \pm 3.83	43.0 \pm 7.63
Resting	25.48 \pm 8.22	16.96 \pm 4.9	28.87 \pm 1.14	20.80 \pm 4.07
Preening	7.92 \pm 1.44	8.18 \pm 6.03	27.04 \pm 4.28	12.53 \pm 8.58
Flying	16.46 \pm 0.98	15.3 \pm 1.00	12.75 \pm 2.14	21.15 \pm 3.44
Alert	2.47 \pm 0.76	3.1 \pm 1.4	11 \pm 0.32	2.24 \pm 0.24

DISCUSSION

The foraging behaviour of Great White Pelicans is diverse. They feed on a variety of food. As noted by other authors, they are largely piscivorous (Feely, 1962; Whitfield and Blaber, 1979). In the present study area, fish were an important prey items in the diet of *P. onocrotalus* both in the wet and dry seasons. High feeding frequency on fish was observed during the dry season. This might be because of the seasonal dropping of water level which provides better access to fish for non-diving pelicans, because the water level recession during the dry season concentrates fish into isolated pools of shallow water where the birds can forage effectively as indicated by Gawlik (2002). Prey items are not exclusively restricted to fish. Across their range of distribution, Great White Pelicans feed on fish and other aquatic organisms as indicated by Hoyo *et al.* (1992). Their scoop-feeding method enables them to take a very variable size of prey. Johnsgard (1993) also showed that they were able to exploit other sources of food such as amphibians, worms and other invertebrate and they even scavenge on dead animals or fish discards. Similar findings were also observed during the present investigation around Lake Hawassa. The consumption of small-sized food items by the bird was not frequent even if they were available in their foraging area. This might be related with the energy gain and the suitability of their beak size to collect and capture the small-sized prey. MacArthur and Pianka (1966) also noted that a predator should rank prey

types according to their energy value per handling time. The Great White Pelicans were often seen feeding solitarily, or socially in groups that averaged 3-6 in number, but very seldom in groups greater than 30. This differs from the observations of these birds in Lake St. Lucia, South Africa made by Bowker and Downs (2008b), where the largest feeding group numbered 4000 and the average size was 1000 birds per flock, but more similar with the observation of Din and Eltringham (1974) in Uganda. These authors recorded that the Great White Pelicans were often seen feeding solitarily or socially in groups that averaged 8.5 in number, but very seldom in groups >50.

Birds exhibit great flexibility in adjusting time budget to maintain their daily requirements (Das *et al.*, 2011). The evolution of activities and social behaviour is influenced to a large extent by environmental factors such as water and food distribution and abundance, weather condition, day and season length, habitat characteristics and predation pressures (Crook, 1964). Great White Pelicans change their activities during morning, afternoon and evening periods. Feeding was the most time-consuming activity of Great White Pelicans because energy requirements are the key factor in the time allocated to feeding. It was probably because of the smaller size and limited number of their prey items that Great White Pelicans were forced to spend more time in feeding than on other forms of behaviour. The peak intake of food was during late morning and the lower food intake during mid-day both in wet and dry seasons. More feeding activities during the morning and evening might reflect the effects of temperature on feeding activities and also reflects their need to obtain energy for overnight energy requirements as indicated by Asokan *et al.* (2010). Resting is the major mid-day activity of most birds (Martinez, 2000). Great White Pelicans rest during mid-day on the rocky lakeside adjacent to the shore and on exposed roots of large trees, when feeding activity was at its lowest level. An increase in resting during mid-day may be a mechanism to minimize the heat load of birds at high environmental temperature as suggested by Martinez (2000). The wing plumage, breast and back were the body parts most often preened by Great White Pelicans followed by the neck and feet. The most frequent comfort activities were feather shaking and wing flapping. Time spent on this kind of body maintenance activities were recorded in several bird species (Martinez, 2000). Preening gradually increased when the flock size increased. The longer time spent on preening with increased flock size could also be explained by the synchronization of behaviour in flocking birds in response to the stimuli elicited by the activity of other individuals, as

reported by Bruggers and Jackson (1977). During the present study, Great White Pelicans spent less time on alert behaviour, suggesting that there are no serious threats to the Great White Pelicans in the present study area.

Anthropogenic disturbances including agricultural activities, deforestation, urban expansion, overexploitation of fish, industrial and urban effluents and solid waste littering on lakeshore were commonly observed activities during the study periods around Lake Hawassa. These anthropogenic activities might have negative effect on the habitat of Great White Pelicans and other water birds of the lake. Therefore, human activities should be properly managed to conserve water birds of the lake.

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