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Diurnal activity pattern and foraging behaviour of common kingfisher (*Alcedo atthis*) in Dal Lake, Srinagar, Jammu and Kashmir

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Abstract

The present study documents diurnal activity and foraging behaviour of the common kingfisher (*Alcedo atthis* Linnaeus 1758) in a human dominated landscape, at the shore line of the famous Dal Lake, Jammu and Kashmir, India. Data pertaining to diurnal activity and foraging behaviour were collected in three time slots starting from 06:00 to 09:00 h, 09:00 to 12:00 h and 16:00 to 19:00 h from June to July in 2013. Activity patterns including feeding, calling, preening, flying, and scanning were recorded and reported in percentages. Similarly, foraging behaviour was studied by observing hunting strategies and associated environmental factors. The percentage of total diurnal activity did not change across different time slots ($H = 1.713$, $P = 0.425$) whereby scanning activity consisted of the largest proportion (52.84%) during the time slots, followed by flying (28%) and feeding (13%). Utilization of simple non-feeding perch types and feeding perch types differed statistically significantly ($G = 24.42$, $P < 0.05$). Diving from perch sites was predominant (83%) than diving after hovering (17%) by the common kingfisher. Hovering then diving to hunt increases from the morning hours (14%) to evening hours (20%). Foraging success from a perch was 71%, whereas foraging success for diving after hovering was 38% only. Further ecological studies on common kingfisher should be conducted to know more about the species and its interaction with the environment in the human dominated landscapes.

Key words: Activity pattern, Foraging behaviour, Capture success, Dal Lake, Common Kingfisher

Introduction

Worldwide there are 93 species of kingfishers of which 13 are reported from India (Rasmussen and Anderton 2005). The most common amongst all of kingfishers is the common kingfisher (*Alcedo atthis* Linnaeus 1758) which has largest distribution range in comparison to other kingfisher species breeding across most of the Palaearctic and the Indo-Malayan region in south-eastern Asia (Cramp 1985). It is known to inhabit a wide range of habitats for example, in temperate regions, it inhabits clear, slow-flowing streams and rivers, and lakes with well-vegetated banks. It frequents scrubs and bushes with overhanging branches close to shallow open water in which it hunts. In winter it is more coastal, often feeding in estuaries or harbours and along rocky seashores. Tropical populations are found by slow-flowing rivers, in mangrove creeks and in swamps. In case of feeding habits the common kingfisher is primarily a small fish predator, however, may target other food items also including small water crustaceans, vertebrates, insects, etc. by undertaking plunge-and-dive technique (Vilches et al. 2013). These activity behaviours are useful in studying the ecological, behavioural and physiological aspects of birds (Hamilton et al. 2002, Jonsson and Afton 2006), in order to develop appropriate monitoring protocols and eventually better management strategies. These time-activity budgets reflect a

combination of factors including individual physical condition, social structure and environmental conditions (Paulus 1988). Understanding of the foraging behaviour of a species becomes a fundamental step in understanding the biology of the species and more precisely its ecological niche (Galarza and Tellería 2003, Terraube et al. 2011). Each species is adapted to its local environment and utilises the space in accordance with the resources often in the face of ecological constraints.

Despite being the most common species in its distribution (Figure 1), information pertaining to ecological aspects of common kingfishers is not so common in India. Only a few studies have been conducted and that too on sympatric foraging ecology of the kingfishers in India (Ali et al. 2010, Asokan and Ali 2010, Borah et al. 2012, Govindarajalu 2008). The present study aims at investigation of the diurnal activity patterns of the common kingfisher and foraging behaviour along urban human dominated surroundings of Dal lake if the valley of Kashmir.

Study Area

Dal Lake is a large shallow urban, hyper eutrophic lake situated (Latitude 34^o 05' - 34^o 09' N and Longitude 74^o 50' - 74^o 53' E; Figure 1) at an altitude of about 1583 m, in the north-east of the Srinagar city of the Kashmir valley. The lake is known as a tourist attraction providing recreational opportunities to the tourists and local population. Large areas of the lake are covered by floating gardens, which are land masses used for vegetable cultivation. This lake has an approximate area of 25 km^2 comprised of open water area, floating gardens, built-up land masses with human settlements, houseboat areas. Only about 15.41 km^2 is an open expanse of water with a maximum depth of 6 m. The top crust of the lake has also been observed to freeze during extreme winters when the mercury falls to around -11 ^oC. Early spring and summers are the wet periods when maximum rainfall occurs and average annual rainfall recorded is 655 mm. It is in this season that the snow thaws in the higher catchment results in maximum discharge in Dachigam & Dara Nallah which inflow into the Lake. (Lakes and Waterways Development Authority, J&K govt. http://jklda.org/dalnagin.aspx searched on 06.02.2014). The ecosystem of the lake is rich with macrophytes (macro and submerged) like *Ceratophyllum demersum, Myriophyllum spicatum, Potemogetton lucens, Neelambium nucifera, Nymphaea alba, N.Tertagonia, N.Candida* etc. and phytoplanktons like *Navicula radiosa, Nitzschia accicularis, Fragilaria crotonensis, Diatoma elongatum, Scenedesmus bijuga* etc. Other plant species found near the bank outside lake include *Populus* sp., *Salix* sp. *Melia* sp., *Ailanthus* sp., *Robinia* sp., *Daphne* sp., *Celtis* sp. etc. The habitat surrounding the bank does not have any agricultural fields but a few small patches of *Populus* sp. plantations.

Methodology

Activity Pattern

We studied activity pattern of the common kingfishers during the summer season from 29th June to 13th July, along a 4.5 km (Foreshore road) stretch of riverine habitat along the northern bank of the Dal Lake. The observations were made from early morning to late evening dividing the day into three time slots; early morning 6:00hr to 9:00hr, late morning 9:00hr to 12:00hr and then in the evening from 16:00hr to 19:00hr. Observations were made opportunistically at five different study points located along the bank stretch with an inter-point separation of 400m to 600m to minimize the pseudo-replication. We standardised sampling protocols to study activity patterns and record activity behaviour of the common kingfisher (Altman 1974). Each observation session comprised of noting down activities of an individual at an interval of 2 minutes, using 8x42 (Nikon Monarch ATB) binoculars, until the bird flew away from the spot.

The activities are divided into five major categories following Asokan et al. (2010):

(i) Scanning: perched in an upright position scanning surroundings actively.

(ii) Flying: in flight, often in pursuit on prey.

(iii) Feeding: capturing prey and swallowing into the buccal chamber.

(iv) Preening: comfort movements including feather shaking, wing flapping, bill cleaning, bill scratching, body and tail shaking.

(v) Resting: perched sleeping or dozing with head retracted and eyes closed.

(vi) Others: activities such as calling, showing agnostic activity, etc. was classified as others.

Foraging behaviour

Data pertaining to foraging behaviour were recorded only from individuals considered to be scanning the habitat for food. Each foraging attempt was comprised of making an attempt to acquire food or prey item and recording the habitat variables until the bird flew away. We identified two types of perches: simple/non-feeding and feeding perch types. We define non-feeding perch as the one which the common kingfisher used only to perch and scan while feeding perches were used after making a prey. Thus, we broadly classified foraging strategy adopted to hunt into two categories based on the generic foraging behaviour of the kingfishers (Forsell 1983, Kasahara and Katoh 2008, Vilches et al. 2013) as –

(a) Perch Hunting: bird perched on a substrate and scanning then diving to hunt a prey in water

(b) Hovering and hunting: where the bird hovers in air for a brief period which is followed by hunting the prey in aquatic medium

(c) Abort Hunt: a bird sallies in pursuit of hunting a prey but aborts the hunt without making a kill

Statistical analysis

We calculated proportions or percentages of the diurnal activities and foraging behaviours. We tested the hypothesis that diurnal activities across different time slots of the day are different for which we used Kruskal-Wallis test which is a distribution free, non-parametric test as our data deviated from normal distribution. We examined whether the common kingfisher used the simple and forage perch types statistically differently using the G-test. We also used the chi-squared test to determine whether there was a difference amongst various perching substrates from within a perch type. All measured values are shown as mean ± SE. The analyses described above were conducted using SPSS ver. 15 (SPSS Inc. 2006).

Results

Activity Pattern

A total of 1588 minutes were spent in observing the diurnal activity patterns of the common kingfisher. It spent most of the time in scanning (about 53%) the area followed by flying (about 28%) in search of prey. Only about 13% of the total daily diurnal activity was spent on feeding (Figure 2). The percentage of total diurnal activity did not change across different time slots ($H = 1.713$, $P = 0.425$) whereby scanning (about 51% to 53%) and feeding (about 11% to 14%) remained consistently high activities throughout the day (Table 1).

Foraging behaviour

The common kingfisher utilized non-feeding perch types and feeding perch types statistically differently ($G = 24.42$, $P < 0.05$) and within the non-feeding perch type use also differed significantly ($\chi^2 = 2077.78$, $P < 0.01$) with ground/bank being used the most (about 66%). Similarly, within feeding perch utilization also differed significantly ($\chi^2 = 630.33$, $P < 0.01$) with the percentage utilisation increasing to about 73% (Table 2). Interestingly, the common kingfisher used the electric wires or poles and boat (*shikara*) as non-feeding perch only 2% and 5%, respectively, but did not use these as feeding perch after making a prey (Table 2). The mean perch height amongst all feeding perch types was 1.02±0.08 m. In using feeding perch types the common kingfisher occasionally utilised tall vegetation due to which the mean maximum height got increased to 5.5±1.04 m (Figure 3).

Perusal of Figure 4 suggests that diving from perch sites was more predominant (83%) than diving after hovering (17%) by the common kingfisher. Hovering then diving to hunt increases from the morning hours (14%) to evening hours (20%). Foraging success from a perch was 71%, whereas foraging success for diving after hovering was 38% only. The percentage of foraging attempts which were aborted midway was more in case of hovering (31%) than the perch hunting (4%) (see Figure 5). Capturing success increases from morning to evening in both the perch (66% to 76%, respectively) and hovering (20% to 50%, respectively) hunting strategies (Table 3).

Discussion

Our results indicated that for common kingfishers scanning the hunting area is the most predominant activity which helps in deciding to accurately pin point the site to hunt at a particular point of time. This is in accordance with other studies (Vilches et al. 2013) whereby, researchers have found that the common kingfishers and kingfishers in general have wait and hunt strategies where wait actually defines scanning the area of hunt. Scanning is a widespread behaviour amongst predatory birds (Ettinger and King 1980, Mahabal 1991, Sivakumaran and Thiyagesan 2003). Since, a large amount of time is spent in scanning the area and sallying to suitable points to hunt, this has to be compensated by preying fish to gain energy almost at all times of day as our results suggest. This has also been supported by other studies which suggest that kingfishers have to balance their energy requirements during long spell of night by consuming food in the evening hours at the same rate as that in the morning (Kelly 1998).

The Common Kingfishers are known to have smaller niche breadths in comparison other kingfishers owing to their smaller body size (Kasahara and Katoh 2008, Borah et al. 2012). Therefore, they spend most of their time scanning the area utilizing more shores/banks and/or vegetation nearby the water bodies with comparatively shallow water depths and relatively calm waters (Kasahara and Katoh 2008, Borah et al. 2012). In the present study also this has been observed that the maximum utilization of the ground or artificial substrate along the bank of the Dal Lake has taken place. Similarly, the mean feeding perch height attained was about 1.02 m with a maximum of 5.5 m in case of vegetation, this vertical perch height is in conformation of other studies (Borah et al. 2012) whereby they have accounted for similar foraging heights. Although, higher perch heights are considered to provide potential energy or momentum to the birds to hunt deep in the water but the foraging behaviour of the common kingfishers is in contrast of this theory because of their dependence on smaller prey which are generally more accessible on the surface in comparison to deep dwelling prey which is not seen directly (Vilches et al. 2013). A few of the studies have also mentioned about the horizontal foraging distance moved by the common kingfishers which was about 2 m (Borah et al. 2012), we also found these kingfishers to be foraging horizontally near the banks only often within to 5-10 m (data not presented).

The hunting strategies adopted by common kingfishers are generally of two kinds one of which is hunting from perch which is predominant, hovering then hunt has also been reported but at smaller level (Kasahara and Katoh 2008). Hunting from perches seems to benefit the kingfishers for two reasons; first they mostly remain unseen by the prey in water and secondly perch heights give energy to propel themselves deep into water (Kasahara and Katoh 2008, Borah et al. 2012). While on the other hand, hovering then hunt does not give much success to the common kingfishers as they hover too low in comparison to other kingfisher species (for example, Pied Kingfisher *Megaceryle lugubris* and Pied Kingfisher *Ceryle rudis*). Our results also depict the same where the common kingfisher has much higher capturing success in hunt from perch in comparison to hover then hunt strategy.

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Figure 1: Distribution range of the Common Kingfisher (*Alcedo atthis*) and location of the Dal Lake (study area).

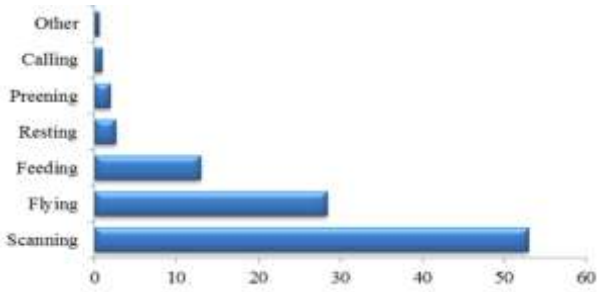

Figure 2: Overall (%) diurnal activities of the Common Kingfisher

Table 1: Diurnal activity (%) during different time slots of the day

Activity	Time Slots (hour)		
	06:00 – 09:00	09:00 – 12:00	16:00 – 19:00
Scanning	51.9	53.6	53.2
Flying	25.4	32.0	28.7
Feeding	13.0	11.3	13.6
Resting	4.6	1.4	1.7
Preening	3.2	0.9	1.7
Calling	1.4	0.5	0.8
Other	0.6	0.5	0.4

Table 2: Percentage perch used: Non-feeding Perch Type is normal perch observed where the common kingfisher did not feed while Feeding Perch Type is exclusively after the kingfisher made a prey.

Perch Type	Utilization of perch sites (%)							
	Boat	Built up	Electric Wire or Pole	Metal Fence	Ground or Bank	Pipe Line	Sticks in water	Vegetation
Non-feeding	5.30	1.03	1.81	9.69	66.15	8.79	3.36	3.88
Feeding	-	3.08	-	7.18	72.82	9.23	3.59	3.59

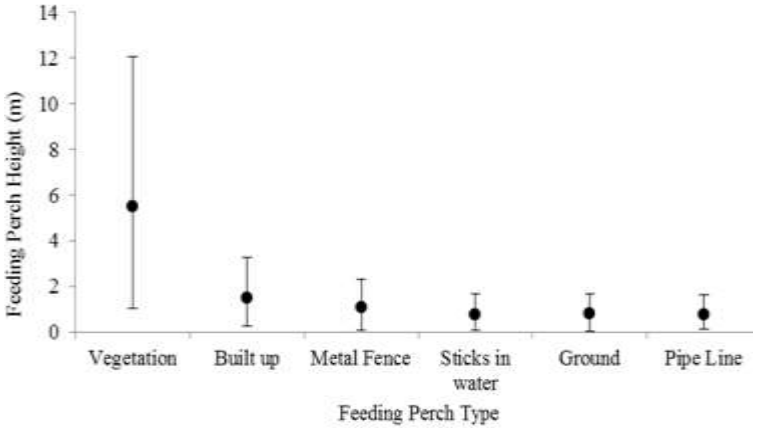

Figure 3: Feeding perch height gained by the common kingfisher after catching prey on different perch types. Error bars indicate the maxima and minima.

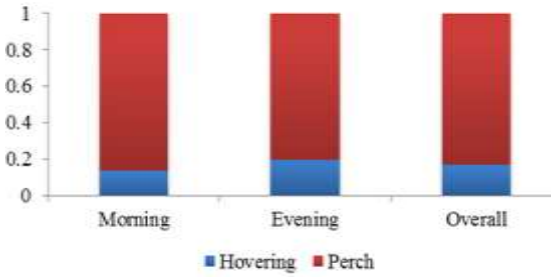

Figure 4: Proportion of foraging strategy adopted by the common kingfisher during morning and evening to capture prey

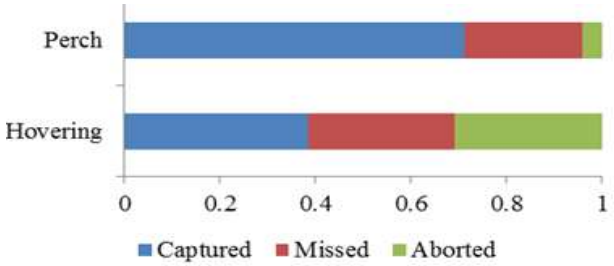

Figure 5: Overall prey capturing success of the common kingfisher in foraging strategies.

Table 3: Proportion of prey capturing success of the common kingfisher during morning and evening foraging events in different foraging strategies.

Capturing Success	Hunting strategy (%)			
	Hovering		Perch	
	Morning	Evening	Morning	Evening
Captured	0.20	0.50	0.66	0.76
Missed	0.53	0.17	0.29	0.20
Aborted	0.27	0.33	0.04	0.04