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## ABSTRACT

The Eurasian Spoonbill (Platalea leucorodia), a charismatic wading bird of wetland habitats, displays complex and adaptive behavioural patterns essential to its survival and reproductive success. This study examines the behavioural ecology of the species at Soor Sarovar Bird Sanctuary (SSBS), Agra, from 2021 to 2023. Using focal animal and scan sampling techniques, a comprehensive ethogram was developed to monitor ten categories of behaviours, including locomotion, maintenance, feeding, reproductive activities, and social interactions. Observations were conducted between 9:00 AM and 4:00 PM, with behaviours recorded at 30- minute intervals. Results revealed seasonal variation in activity budgets, with locomotion and foraging peaking during low water periods, suggesting behavioral plasticity in response to environmental cues. Reproductive behaviours, including courtship and nesting, were concentrated in pre-winter periods, reflecting synchronization with optimal ecological conditions. Agonistic and interspecific interactions highlighted the Spoonbill's competitive yet socially cohesive nature within mixed-species assemblages. Notably, the species demonstrated versatile feeding strategies across microhabitats, aided by both tactile and visual foraging techniques. The Spoonbill's ability to adapt its behaviours to fluctuating wetland conditions illustrates its ecological resilience.

Compared to other sympatric waders, it exhibited a broader behavioural repertoire, likely conferring a competitive advantage in dynamic habitats. This study underscores the importance of sustained behavioural monitoring for informing conservation strategies, especially in light of anthropogenic pressures and habitat modifications at SSBS. The findings contribute valuable insight into the adaptive strategies of P. leucorodia, reinforcing the significance of wetland conservation for sustaining avian biodiversity.

***Keywords:*** *Wetland, behaviour, Environmental, anthropogenic, conservation etc.*

## INTRODUCTION

Birds, or Aves, are among the most captivating members of the animal kingdom and play a vital role in our planet's biodiversity. They are warm-blooded, egg-laying vertebrates, easily

recognized by their feathers and the transformation of their forelimbs into wings—an adaptation that enables flight in most species. Instead of teeth, birds possess beaks that serve the dual purpose of feeding and manipulating objects, much like hands and mouths combined. With their vibrant plumage and distinctive vocalisations, especially during the breeding season, birds are relatively easy to observe and identify, making them a favourite among wildlife enthusiasts and researchers alike.

Birds inhabit nearly every corner of the globe and exhibit a remarkable variety of forms and behaviours. Their diversity is often regarded as a strong indicator of the health and stability of ecosystems. Greater bird diversity typically reflects a resilient environment, capable of withstanding both natural and anthropogenic changes. Examining bird diversity and distribution not only highlights regions that support rare or threatened species but also informs conservation efforts by identifying habitats that require protection.

Long-term monitoring of bird populations can reveal trends linked to environmental changes, such as habitat degradation, climate shifts, or the introduction of invasive species. Understanding where and how different bird species exist offers insights into their ecological roles, habitat preferences, and tolerance levels. This, in turn, illuminates patterns of species coexistence and competition.

Wading birds—or waders—include species from various taxonomic groups such as storks (Ciconiiformes), cranes and allies (Gruiformes),

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herons, egrets, spoonbills, and ibises (Pelecaniformes), and flamingos (Phoenicopteriformes). These birds are closely tied to wetland environments like marshes, swamps, and shallow lakes. Wetlands offer critical feeding and nesting grounds for waders, making the conservation of these habitats essential for their survival [1]. Wading birds, or waders, stand out from other avian groups due to their unique physical features and specialised behaviours. One of their most distinctive traits is their long, slender legs, which allow them to walk easily through muddy and shallow water while maintaining balance. These legs help them access deeper feeding areas that other birds can't reach. Their bills are also specialised, ranging from sharply pointed to curved or spoon-shaped, each form adapted to suit different types of prey. Waders typically have long, flexible necks with strong muscles, allowing them to strike with precision while foraging. Waders can significantly modify their prey detection and hunting techniques depending on their environment [2].

Among these remarkable birds is the Eurasian Spoonbill (Platalea leucorodia), also known as the Common Spoonbill. This elegant wader belongs to the family Threskiornithidae under the order Pelecaniformes. Its distribution spans a broad region, stretching from the eastern Atlantic

across Europe and Asia, including India and China. The species is divided into three recognised subspecies: Platalea leucorodia leucorodia, Platalea leucorodia archeri, and Platalea leucorodia balsaci. The subspecies P. l. Leucorodia is the most widespread, found across much of Europe, the Persian Gulf region, and the Indian subcontinent, including Sri Lanka.

The Eurasian Spoonbill is typically associated with wetlands, where it prefers to forage in groups. Adult birds measure between 70 and 95 cm in length, with a wingspan ranging from 115 to 135 cm, and weigh between 1130 and 1960 grams. During the breeding season, the males develop striking features: a pure white body, a warm yellowish patch at the base of the neck, and a vivid orange hue around the bill. The chin and throat area also becomes bright orange, and long, plume-like feathers form a crest at the crown of the head. The bird's long, flat bill is mostly black with a distinctive orange tip, and its eyes are red. The legs and feet are black, adding to its bold appearance.

**Fig. 1:** Eurasian Spoonbill adult

In the non-breeding season, these colours fade. The bill retains its black colour, but the yellow tip becomes more subdued. The orange tint on the chin and throat diminishes, and the yellow collar patch appears duller or sometimes incomplete. Males and females look alike, although females are generally smaller in size [3]. Juveniles resemble non-breeding adults but can be recognised by their pinkish bill and black-tipped primary feathers.

Despite facing local pressures in some areas, the Eurasian Spoonbill has a broad geographic range and stable population trends. It is currently classified as a species of Least Concern by Bird Life International (2021). India enjoys the highest level of legal protection under Schedule

I of the Wildlife Protection Act, 1972 (State of India's Birds, 2023), reflecting its ecological importance and

the need for continued monitoring and habitat conservation .

Behavioural Ecology

Studied the feeding ecology of the Eurasian spoonbill in the German Wadden Sea [4]. They revealed that the Eurasian spoonbill has opportunistic foraging strategies with marine fish. Using GPS trackers, Rodrigues et al. (2023) monitored juvenile Eurasian spoonbills in Portugal to evaluate their habitat choices and ontogeny of habitat usage. Although manmade habitats such as rice fields, saltpans, and wastewater treatment plants were found as alternate habitats, they stated that intertidal wetlands were the most utilized habitat.

[5] also conducted a study in Sub-Himalayan terai dooar wetlands about the foraging habitat and feeding strategies of water birds by giving major emphasis on foraging guilds. A higher diversity of waterbirds was found in shallow and medium water habitats than in deep waters. It concludes that the specialist guild members showed comparatively higher levels than generalist guild members. This indicated the waterbird communities were influenced mostly by trophic resources at a site and the birds' ability to exploit them. [6] investigated the spatial distribution and feeding efficiency by interspecific interaction between little Egrets and Eurasian Spoonbills in the Gulf of Gabes, Tunisia. The Little Egrets were seen having higher pecking rates and prey intake while foraging in association with the Eurasian Spoonbill.

[7] studied the ecology of wading birds in a 6 m high irrigation dam and observed that wading birds preferred less water depth, i.e., 2 m or less. The inter-bird distance was seen to be decreasing there, and the change in territorial attack and territory size takes place with the change in water level. [8] documented the minor changes in the behaviour of Spoonbill in captivity in the anthropogenic environment with a pair of Painted Stork. Alteration in artificial nest platforms by using supplementary nesting material, factors affecting breeding success, and conflicts for territory between both species were observed, and both parents were seen foraging together, leaving eggs/chicks alone.

[9] worked on the importance of drainage channels for waders foraging on tidal flats and observed that waders prefer to forage near water channels and remain distributed nearby even at a scale of a few meters.

Study Area

Soor Sarovar Bird Sanctuary (SSBS), Keetham, Agra, is one of the most important bird sanctuaries in Uttar Pradesh. It comprises an artificial freshwater wetland or jheel in which the river Yamuna flanks on its northern periphery, producing a mosaic of ecological niches. In 1991, the Government of Uttar Pradesh declared it a Bird Sanctuary under the Wildlife Protection Act of 1972. SSBS is listed as an Important Bird and Biodiversity Area (IBA) and was declared a Ramsar site in November 2020.

SSBS is located between N27°14' 38" and N27° 31'51" latitude, E77° 49'38" and E77°52'40" longitude, 20 km away from Agra district headquarters on Agra-Delhi highway (NH 2) (Fig. 2; 3). Its entire catchment area is 7.97 km2, while the lake is spread over 2.25 km2 with a depth ranging from 4 to 8 meters.

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Fig. 2: Map of the Study area, Soor-Sarovar Bird Sanctuary


Fig. 3: Map of Soor Sarovar Bird Sanctuary (Credit: https://www.soorsarovarbirdsanctuary.in/maps.html)

The region experiences ample rainfall during the monsoon season (June to mid-September) and the annual temperature ranges from 4-48°C. SSBS is surrounded by dry deciduous forests and supports a rich biodiversity. It gives shelter to 165 species of migratory and resident birds. It is a good tourist attraction providing fruitful bird-watching from October to April. SSBS has the biggest Bear Rescue centre for rescued dancing bears.

Though it has been known as a paradise for both migratory and non-migratory birds, it is threatened by various anthropogenic activities like poaching, grazing of cattle, and fishing within the premises.

## MATERIALS AND METHODS

The fieldwork spanned across multiple seasonal cycles to capture both breeding and non- breeding behaviours. Observations were made continuously over 12–24 months, covering the pre-breeding, breeding, and post-breeding periods to ensure a comprehensive behavioural assessment.

A combination of focal animal sampling and scan sampling methods [10] was employed to study individual and group behaviours, respectively. The ethogram dataset for the Eurasian Spoonbill at Soor-Sarovar Bird Sanctuary, covering the period from September to February for each year separately from 2021-22 to 2023-24, was constructed. The data was recorded at 30-minute intervals from 9:00 AM to 4:00 PM (14 time slots per day).

All behavioural data were recorded using binoculars and a spotting scope from a safe and non-intrusive distance. A camera with a telephoto lens was used to photograph specific behavioural events for documentation and later analysis.

**Behaviour Categories and Ethogram Development:** A preliminary ethogram was developed after pilot observations, categorising the behaviours of Eurasian Spoonbills into the following:

1. Locomotion: Locomotory behaviours were categorised into walking, flying, hopping, wading, and swimming. Frequency and duration were noted to assess activity budgets. Movements between foraging, resting, and nesting sites were recorded using GPS tracking where feasible.
2. Maintenance Behaviour: Behaviours related to self-care, such as preening, bathing, stretching, scratching, and bill-wiping, were recorded. These actions were observed during different times of the day and across seasons to note patterns in maintenance routines.

3. Daily Habits and Activity Patterns: Time-activity budgets were constructed by recording the proportion of time spent on each behaviour (foraging, resting, flying, maintenance, etc.) over defined intervals. This helped determine circadian rhythms and daily energy allocation.
4. Sleeping and Roosting Behaviour: Sleeping postures, timing of roosting, and selection of roosting sites were observed, especially during the evening hours. Roosting group size and position in mixed-species assemblages were noted.
5. Agonistic Behaviour: Instances of aggression or dominance interactions were documented both within species (intraspecific) and between species (interspecific). Displays, chases, pecks, and vocal warnings were categorised, and their context (feeding site, nesting site, etc.) was recorded.
6. Acoustic Behaviour: Vocalisations were recorded using a directional microphone and analysed for different behavioural contexts such as alarm calls, contact calls, or breeding- related vocalisations. Where possible, spectrographic analysis was done using Raven Pro software to categorise and describe call types.
7. Gregariousness: The social structure of foraging and roosting groups was assessed by counting flock size, spacing patterns, and coordinated activities. Cooperative and synchronised behaviours were documented, and their association with other waterbirds was studied.
8. Feeding Behaviour: Feeding methods (e.g., tactile sweeping, pecking, probing) were recorded along with prey type whenever visible. The use of different microhabitats (depth, vegetation type) during foraging was documented to understand habitat-food linkages.
9. Reproductive Behaviour: Courtship displays, pair bonding, nest site selection, copulation, egg-laying, incubation, and chick-rearing behaviours were monitored. Nest success and parental investment (e.g., feeding frequency, nest guarding) were noted through repeated visits to breeding colonies.
10. Intraspecific and Interspecific Interactions: Interaction with conspecifics and other bird species was recorded, especially in contexts such as foraging, roosting, or territorial disputes. Instances of competition or mutualism (e.g., shared vigilance, alarm calls) were noted with supporting field notes. Behavioural events were cross-verified using photographs and videos when possible, and unusual behaviours were discussed with expert ornithologists to ensure correct interpretation. Ethical Considerations: All fieldwork was conducted with minimal disturbance to the birds and their habitats. Observations were made from designated bird-watching hides or camouflaged positions. The study adhered to the Wildlife (Protection) Act, 1972 and any local site-specific regulations.

## RESULTS

Different behavioural activities were recorded under certain parameters:

- Locomotion (Walking, Flying, Wading, Swimming)
- Maintenance (Preening, Bathing, Stretching)
- Habits (Roosting, Perching, Socialising)
- **Sleeping Behaviour** (Duration of rest on one leg, resting with beak in feathers)
- **Agnostic Behaviour** (Territorial defence, Threat displays)
- **Gregarious Nature** (Flock formation, Individual vs. group behaviour)
- **Feeding Behaviour** (Diet items, foraging techniques, Feeding success)
- **Reproductive Behaviour** (Courtship, Nest building, Incubation, Chick-rearing)
- **Intraspecific Interactions** (Social hierarchy, Conflict, Cooperation)
- **Interspecific Interactions** (Co-existence with other species, Competition, Predation threats)

The mean annual activity for all the behaviours was recorded. The mean annual locomotion activity budget was maximum (10.11±0.19) in 2023-24 and minimum (9.96±0.19) in 2022-23, followed by 10.7±0.18 in 2021-22, respectively. The mean annual maintenance activity budget was maximum (9.97±0.19) in the year 2022-23 and minimum (9.93±0.18) in 2023-24, followed by 9.74±0.19 in the year 2021-22, respectively. The annual mean habit activity budget was maximum (10.33±0.19) in the year 2023-24 and the minimum (10.00±0.19) in 2021-22, followed by 10.09±0.18 in the year 2022-23. The annual mean Sleeping activity budget was maximum (10.06±0.19 and 10.06±0.18) for 2021-22 and 2023-

24, respectively, and minimum (9.95±0.18) in the year 2022-23. The annual mean Agonistic activity budget was maximum (10.12±0.19) in the year 2022-23 and minimum (9.80±0.19) in 2023-24, followed by 9.96±0.19 in the year 2021-22. The annual mean gregariousness activity budget was maximum (9.94±0.19 and 9.94±0.18) in the years 2022-23 and 2023-24, respectively, while the minimum (9.93±0.18) was in the year 2021-22. The annual mean feeding activity budget was maximum (10.05±0.18) in the year 2022-23 and minimum (9.91±0.19) in 2021-22, followed by 10.04±0.19 in the year 2023-24, respectively. The annual mean reproductive activity budget was maximum (10.20±0.17) in the year 2021-22 and minimum (9.84±0.19) in 2023-24, followed by 9.87±0.19 in the year 2022-23, respectively. The annual mean activity budget for Intraspecific interaction was maximum (10.19±0.19) in the year 2023-24 and the minimum (9.83±0.18) in 2022-23, followed by 10.04±0.18 in the year 2021-22, respectively. The annual mean activity budget for Interspecific interactions was maximum (10.22±0.19) in the year 2022-23 and minimum (9.76±0.18) in the year 2023-24, followed by 10.09±0.19 in the year 2021-22, respectively (Table 1; Fig. 4)

**Table 1:** Mean Behavioural Activities of Eurasian Spoonbill

| Behaviours | | 2021-22 | 2022-23 | 2023-24 |
|---|---|---|---|---|
| Locomotion | Mean | 10.07 | 9.96 | 10.11 |
| | SD | 4.45 | 4.62 | 4.58 |
| | SEM | 0.18 | 0.19 | 0.19 |
| Maintenance | Mean | 9.74 | 9.97 | 9.93 |
| | SD | 4.50 | 4.51 | 4.43 |
| | SEM | 0.19 | 0.19 | 0.18 |
| Habits | Mean | 10.00 | 10.09 | 10.33 |
| | SD | 4.50 | 4.42 | 4.66 |
| | SEM | 0.19 | 0.18 | 0.19 |
| Sleeping | Mean | 10.06 | 9.95 | 10.06 |
| | SD | 4.62 | 4.46 | 4.41 |
| | SEM | 0.19 | 0.18 | 0.18 |
| Agonistic | Mean | 9.96 | 10.12 | 9.80 |
| | SD | 4.60 | 4.59 | 4.54 |
| | SEM | 0.19 | 0.19 | 0.19 |
| Gregariousness | Mean | 9.93 | 9.94 | 9.94 |
| | SD | 4.44 | 4.53 | 4.47 |
| | SEM | 0.18 | 0.19 | 0.18 |
| Feeding | Mean | 9.91 | 10.05 | 10.04 |
| | SD | 4.53 | 4.34 | 4.73 |
| | SEM | 0.19 | 0.18 | 0.19 |
| Reproductive Behaviour | Mean | 10.20 | 9.87 | 9.84 |
| | SD | 4.24 | 4.50 | 4.51 |
| | SEM | 0.17 | 0.19 | 0.19 |
| Intraspecific Interactions | Mean | 10.04 | 9.83 | 10.19 |
| | SD | 4.46 | 4.48 | 4.49 |
| | SEM | 0.18 | 0.18 | 0.19 |
| Interspecific Interactions | Mean | 10.09 | 10.22 | 9.76 |
| | SD | 4.54 | 4.55 | 4.34 |
| | SEM | 0.19 | 0.19 | 0.18 |

**ABBREVIATION: SD-** Standard Deviation**; SEM-** Standard Error of Mean

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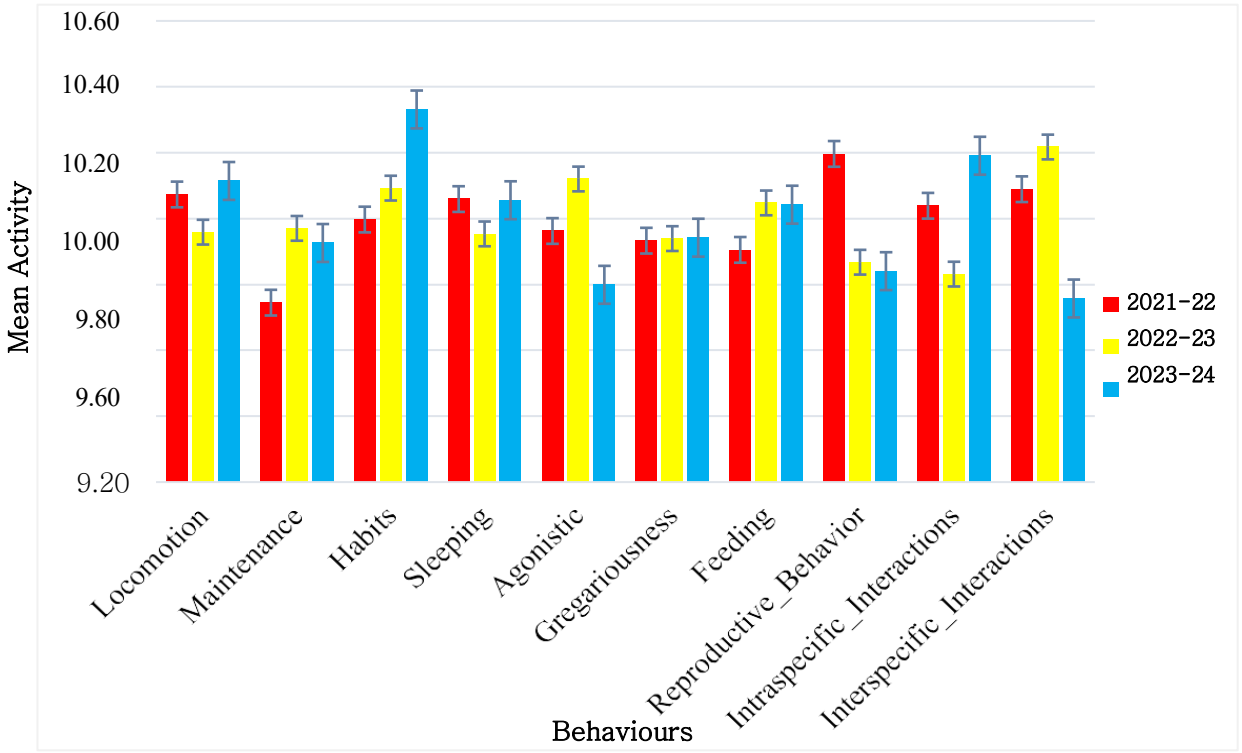


**Fig. 4:** Mean Behavioural activity

All the behaviours were studied and recorded only in the post-monsoon and winter seasons because the population of Eurasian Spoonbill was recorded to be maximum in these seasons. The parameters were separately analysed in both seasons for the mean activity budget and to determine the most active period for the species.

#### 4.2.1 Locomotion

The locomotion activity constitutes walking, Flying, Wading, and Swimming. The mean activity budget during PM was a maximum of 10.23±0.26 in the year 2021-22 and a minimum of 10.03±0.27 in 2023-24, followed by 10.12±0.26 in the year 2022-23. Likewise, during W, the maximum activity budget 10.20±0.26 was reported in the year 2023-24 and the minimum

9.79±0.28 in 2022-23, followed by 9.92±0.26 in the year 2021-22 (Table 2; Fig. 5).

**Table 2:** Mean Locomotion behaviour time budget

| | **PM** | **W** |
|---|---|---|
| **2021-22** | 10.23±0.26 | 9.92±0.26 |
| **2022-23** | 10.12±0.26 | 9.79±0.28 |
| **2023-24** | 10.03±0.27 | 10.20±0.26 |
| | | |

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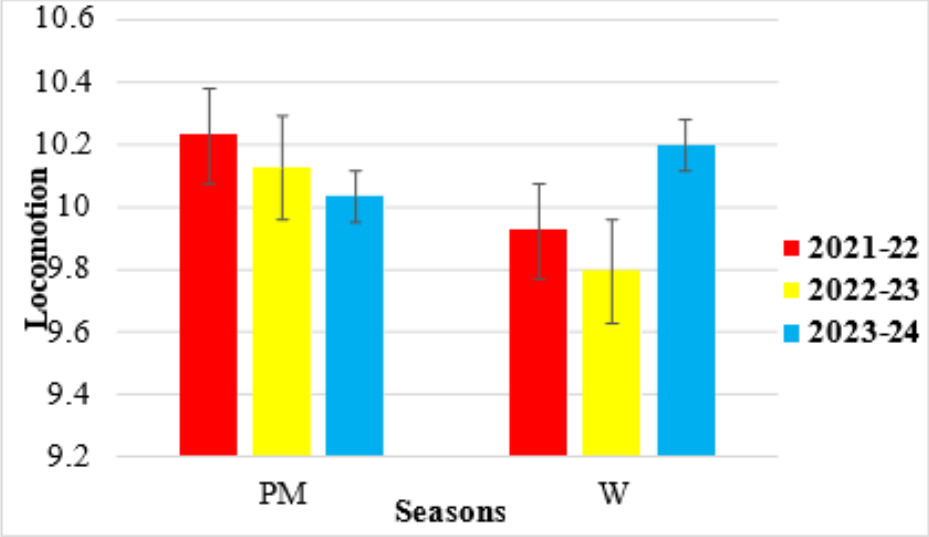


**Fig. 5:** Mean locomotion behaviour time budget

**Maintenance Behaviour**

The maintenance behaviour included several self-maintaining activities like Preening, Bathing, and Stretching. The mean activity budget during PM was a maximum of 10.04±0.26 in the year 2023-24 and a minimum of 9.73±0.26in 2022-23, followed by 9.96±0.26 in the year 2021-23. Likewise, during W, the maximum activity budget 10.21±0.26 was reported in the year 2022- 23 and the minimum 9.53±0.26 in 2021-22, followed by 9.81±0.25 in the year 2023-24 (Table 3; Fig. 6).

**Table 3:** Mean maintenance behaviour time budget

| | PM | W |
|---|---|---|
| **2021-22** | 9.96±0.26 | 9.53±0.26 |
| **2022-23** | 9.73±0.26 | 10.21±0.26 |
| **2023-24** | 10.04±0.26 | 9.81±0.25 |

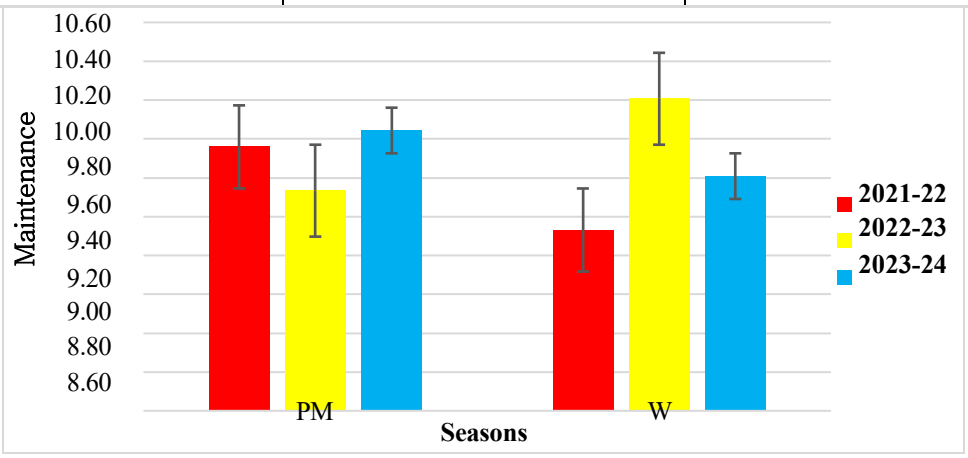


**Fig. 6:** Mean maintenance behaviour time budget

**Abbreviation: PM-** Post Monsoon**; W-** Winter

Habits

The Habits included several activities like Roosting, Perching, and socialising. The mean activity budget during PM was a maximum of 10.36±0.27 in the year 2023-24 and a minimum of 10.01±0.26 in 2021-22, followed by 10.35±0.26 in the year 2022-23. Likewise, during W, the maximum activity budget 10.30±0.27 was reported in the year 2023-24 and the minimum 9.84±0.25 in 2022-23, followed by 9.98±0.27 in the year 2021-22 (Table 4; Fig. 7).

Table 4: Mean habit time budget

| | **PW** | **M** |
|---|---|---|
| **2021-22** | 10.01±0.26 | 9.98±0.27 |
| **2022-23** | 10.35±0.26 | 9.84±0.25 |
| **2023-24** | 10.36±0.27 | 10.30±0.27 |

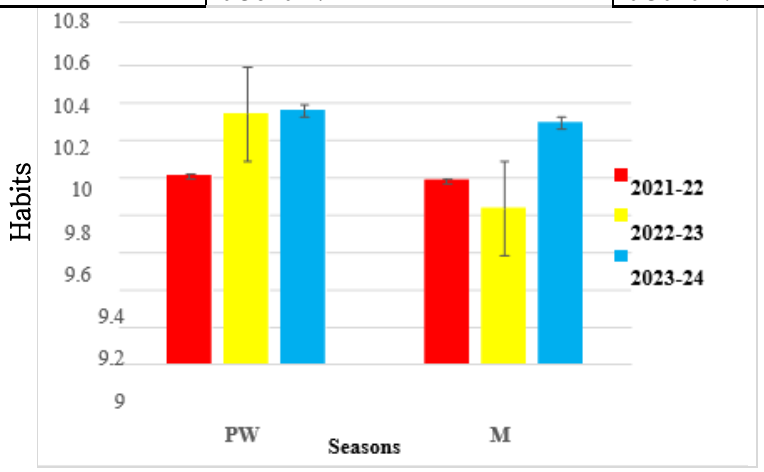


**Fig. 7:** Mean habit time budget

Sleeping Behaviour

The sleeping behaviour included activities like Duration of rest on one leg and resting with the beak in feathers. The mean activity budget during PM was a maximum of 10.02±0.27 in the year 2021-22 and a minimum of 9.67±0.25 in 2023-24, followed by 9.98±0.27 in the year 2022-23. Likewise, during W, the maximum activity budget 10.44±0.26 was reported in the year 2023-24 and the minimum 9.93±0.25 in 2022-23, followed by 10.10±0.27 in the year 2021-22 (Table 5; Fig. 8).

**Table 5:** Mean Sleeping behaviour time budget

| | **PM** | **W** |
|---|---|---|
| **2021-22** | 10.02±0.27 | 10.10±0.27 |
| **2022-23** | 9.98±0.27 | 9.93±0.25 |
| **2023-24** | 9.67±0.25 | 10.44±0.26 |

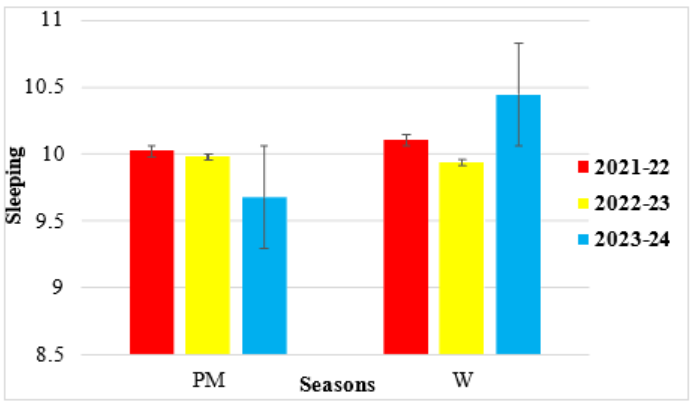


**Fig. 8:** Mean Sleeping behaviour time budget

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Agonistic Behaviour

The agonistic behaviour included activities like Territorial defence and Threat displays. The mean activity budget during PM was a maximum of 9.94±0.27 in the year 2023-24 and a minimum of 9.88±0.26 in 2022-23, followed by 9.89±0.27 in the year 2021-22. Likewise, during W, the maximum activity budget 10.36±0.27 was reported in the year 2022-23 and the minimum 9.66±0.26 in 2023-24, followed by 10.04±0.26 in the year 2021-22 (Table 6; Fig. 9). Table 6: Mean Agonistic behaviour time budget

| | PM | W |
|---|---|---|
| 2021-22 | 9.89±0.27 | 10.04±0.26 |
| 2022-23 | 9.88±0.26 | 10.36±0.27 |
| 2023-24 | 9.94±0.27 | 9.66±0.26 |

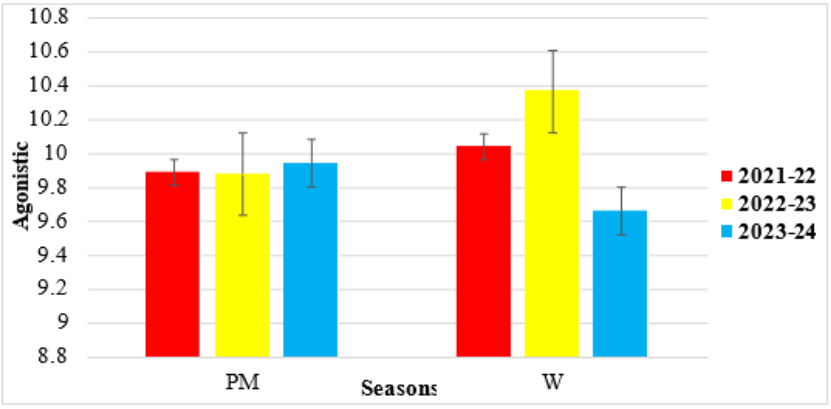


**Fig. 9:** Mean Agonistic behaviour time budget

Gregarious Behaviour

The gregarious behaviour included activities like Flock formation and Individual vs. group behaviour. The mean activity budget during PM was a maximum of 10.15±0.26 in the year 2023-24 and a minimum of 9.48±0.26 in 2022-23, followed by 9.69±0.27 in the year 2021-22. Likewise, during W, the maximum activity budget 10.39±0.27 was reported in the year 2022- 23 and the minimum 9.73±0.26 in 2023-24, followed by 10.17±0.25 in the year 2021-22 (Table 7; Fig. 10).

**Table 7:** Mean Gregarious behaviour time budget

| | PM | W |
|---|---|---|
| **2021-22** | 9.69±0.27 | 10.17±0.25 |
| **2022-23** | 9.48±0.26 | 10.39±0.27 |
| **2023-24** | 10.15±0.26 | 9.73±0.26 |

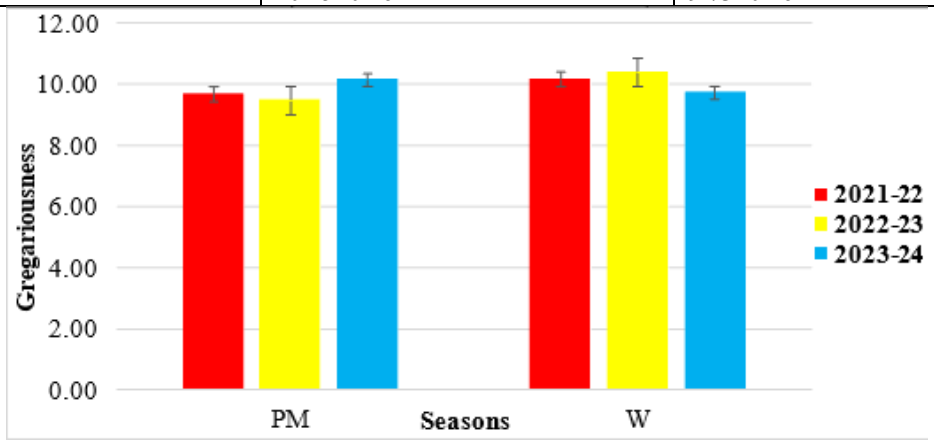


**Fig. 10:** Mean Gregarious behaviour time budget

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Feeding Behaviour

The feeding behaviour included activities like Diet items, foraging techniques, and Feeding success. The mean activity budget during PM was a maximum of 10.19±0.26 in the year 2022- 23 and a minimum of 9.99±0.27 in 2021-22, followed by 10.13±0.28 in the year 2023-24. Likewise, during W, the maximum activity budget 9.96±0.27 was reported in the year 2023-24 and the minimum 9.82±0.26 in 2021-22, followed by 9.91±0.25 in the year 2022-23 (Table 8; Fig. 11).

**Table 8:** Mean Feeding Behaviour Time Budget

| | PM | W |
|---|---|---|
| 2021-22 | 9.99±0.27 | 9.82±0.26 |
| 2022-23 | 10.19±0.26 | 9.91±0.25 |
| 2023-24 | 10.13±0.28 | 9.96±0.27 |

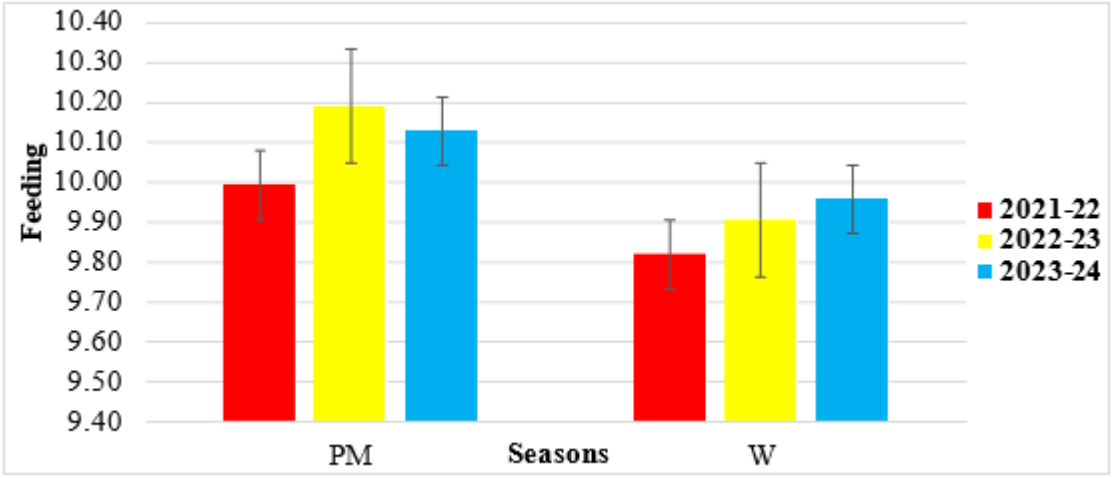


**Fig. 11:** Mean Feeding behaviour time budget

Reproductive Behaviour

The reproductive behaviour included activities like Courtship, Nest building, Incubation, and Chick-rearing. The mean activity budget during PM was a maximum of 10.20±0.25 in the year 2021-22 and a minimum of 9.93±0.27 in 2023-24, followed by 10.10±0.27 in the year 2022-

23. Likewise, during W, the maximum activity budget 10.19±0.25 was reported in the year 2021-22 and the minimum 9.64±0.26 in 2022-23, followed by 9.75±0.26 in the year 2023-24

(Table 9; Fig. 12).

**Table 9:** Mean Reproductive behaviour time budget

| | **PM** | **W** |
|---|---|---|
| **2021-22** | 10.20±0.25 | 10.19±0.25 |
| **2022-23** | 10.10±0.27 | 9.64±0.26 |
| **2023-24** | 9.93±0.27 | 9.75±0.26 |

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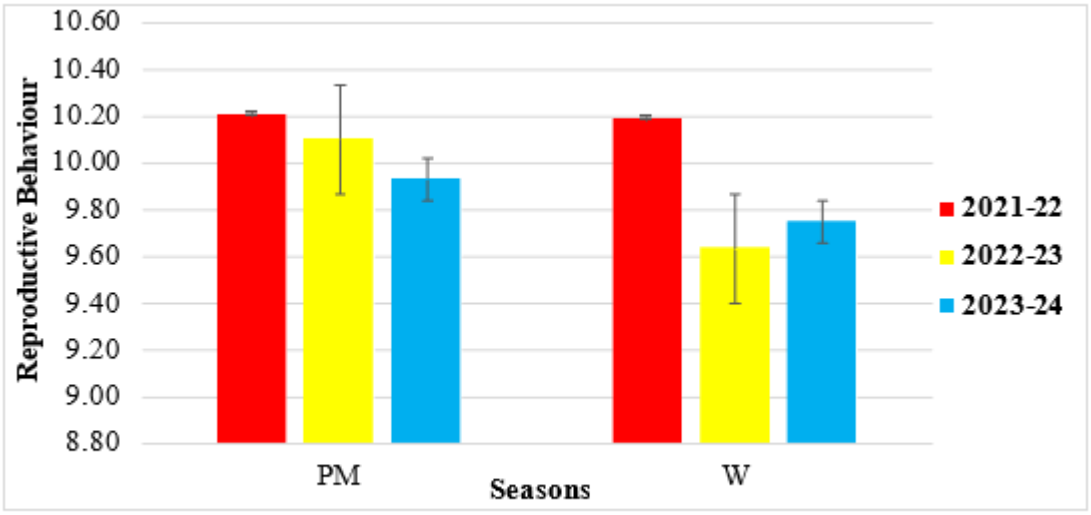


**Fig. 12:** Mean Reproductive behaviour time budget

Intraspecific Interactions

The intraspecific interactions include several activities like maintaining Social hierarchy, Conflict, and Cooperation. The mean activity budget during PM was a maximum of 10.03±0.26 in the year 2023-24 and a minimum of 9.75±0.27 in 2022-23, followed by 9.98±0.24 in the year 2021-22. Likewise, during W, the maximum activity budget 10.35±0.26 was reported in the year 2023-24 and the minimum 9.91±0.26 in 2022-23, followed by 10.09±0.28 in the year 2021-22 (Table 10; Fig. 13).

Table 10: Mean Intraspecific interactions time budget

| | PM | W |
|---|---|---|
| 2021-22 | 9.98±0.24 | 10.09±0.28 |
| 2022-23 | 9.75±0.27 | 9.91±0.26 |
| 2023-24 | 10.03±0.26 | 10.35±0.26 |

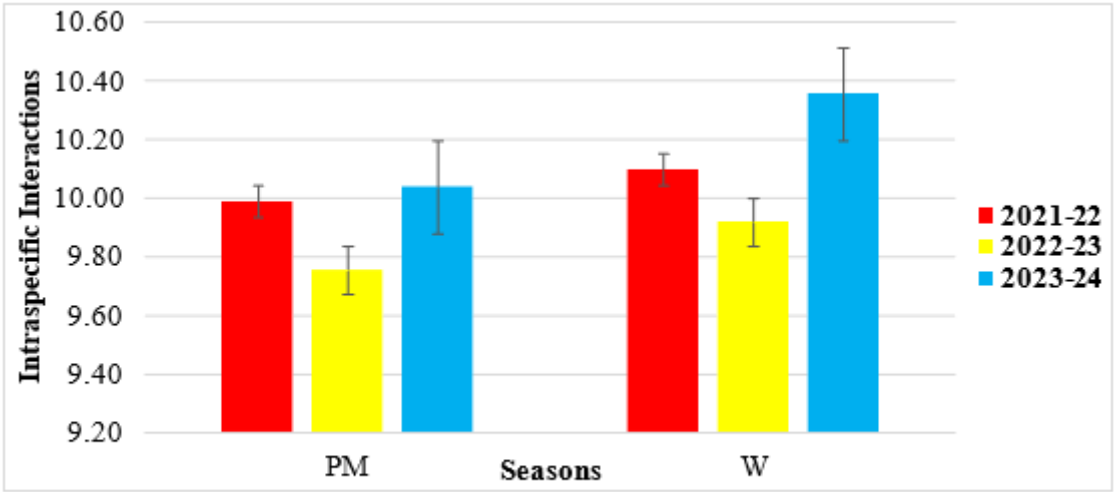


**Fig. 13:** Mean Intraspecific interactions time budget

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Interspecific Interactions

The interspecific interactions included several self-maintaining activities like Co-existence with other species, Competition, and Predation threats. The mean activity budget during PM was a maximum of 10.42±0.27 in the year 2022-23 and a minimum of 9.71±0.25 in 2023-24, followed by 10.03±0.26 in the year 2021-22. Likewise, during W, the maximum activity budget 10.15±0.27 was reported in the year 2021-22 and the minimum 9.81±0.26 in 2023-24, followed by 10.02±0.26 in the year 2022-23 (Table 11; Fig. 14).

Table 11: Mean Interspecific interaction time budget

| | PM | W |
|---|---|---|
| 2021-22 | 10.03±0.26 | 10.15±0.27 |
| 2022-23 | 10.42±0.27 | 10.02±0.26 |
| 2023-24 | 9.71±0.25 | 9.81±0.26 |

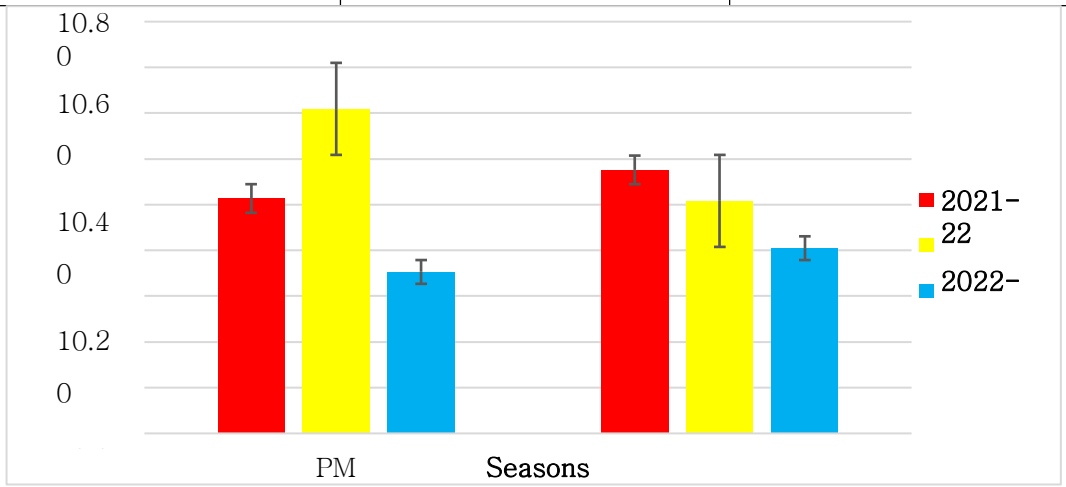


**Fig. 14:** Mean Interspecific interaction time budget

## DISCUSSION

The behavioural ecology of the Eurasian Spoonbill was studied through a comprehensive activity budget, using a detailed ethogram. Observations were made every 30 minutes from 9:00 AM to 4:00 PM, covering a wide range of behaviours including locomotion, maintenance, feeding, and reproductive activities. The data revealed clear seasonal variations, with locomotor activity peaking during the winter months. This seasonal shift aligns with findings from other studies [6,7] and likely reflects environmental and resource-based fluctuations that influence movement patterns.

One of the most striking behavioural traits observed was the species' flexibility in foraging strategies. Foraging activity intensified when water levels were lower, suggesting an adaptive behaviour in response to changing prey availability. Such behavioural plasticity has been previously documented in other spoonbill populations [3,11]. The ability of the Eurasian Spoonbill to use both tactile and visual cues during foraging allows it to exploit a diverse array of microhabitats within wetland ecosystems [2], enhancing its foraging success under variable conditions.

Reproductive behaviour, including courtship displays, nest construction, and chick care, was more frequent during the pre-winter and early winter periods. This timing may be closely linked with optimal environmental conditions that support breeding success. Similar trends have been observed in other wetland-dependent birds [6, 8,13], reinforcing the idea that breeding activities are fine-tuned to environmental cues.

Social interactions also played a key role in the behavioural repertoire of the Eurasian Spoonbill. Behaviours such as group flocking and territorial defence were commonly observed and highlight the species' complex social structure. These behaviours

were consistent with patterns seen in previous studies [4], underscoring the communal nature of this bird.

Interestingly, when compared to other sympatric wader species like the Little Egret and Black- winged Stilt, the Eurasian Spoonbill appeared to exhibit greater behavioural adaptability. Although all these species are subjected to similar ecological constraints, the Spoonbill's broader behavioural toolkit seems to offer it a significant advantage, especially in dynamic wetland environments [5-6,14].

## CONCLUSION

The behavioural patterns of the Eurasian Spoonbill, observed through seasonal shifts and daily activity budgets, highlight the species' remarkable adaptability to its wetland habitat. From increased locomotion in winter to heightened foraging during low water levels, each behaviour appears finely tuned to changing environmental conditions and resource availability. The Spoonbill's ability to alternate between tactile and visual cues while foraging, along with its synchronised reproductive activities and strong social interactions, showcases its ecological versatility.

These findings suggest that the Eurasian Spoonbill not only responds to but anticipates environmental changes, adjusting its behaviour in ways that likely enhance its survival and reproductive success. Compared to other wading birds sharing the same habitat, its broader behavioural range may offer it a competitive edge in fluctuating ecosystems. This study adds to the growing understanding of how species like the Eurasian Spoonbill use behavioural flexibility to navigate the challenges of dynamic wetland environments, offering valuable insights for future conservation and habitat management efforts.

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