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RESEARCH ARTICLE

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Never be mute about bird welfare: Swanning around with environmental enrichment

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Abstract

Environmental enrichment (EE) is commonly provided to animals managed under human care, being beneficial to behavioral diversity and improving animal welfare. Use of EE appears to be particularly beneficial to individual wild animals spending a short period of time in captivity, for example, as part of conservation or rehabilitation programs. This paper documents a case study on the application and relevance of EE for a group of captive mute swans housed in a rescue center. Observational data were analyzed for two groups of juvenile swans that were provided with a physical EE device to increase time spent foraging. Periods of no EE were observed and compared to data from when birds were provided with EE. Results show that EE promoted foraging time and helped to reduce long periods of inactivity in captive birds. EE helped to reduce occurrence of captive-focused (i.e., abnormal behaviors) although these was already seen at very low rates. Inactivity as a measure of welfare in captive swans specifically (and waterbirds generally) should be further investigated to understand potential impacts on bird health. Our research shows the benefits of simple and easy-to-use EE devices on captive animal behavior and how use of EE for individuals spending a short amount of time in captivity (e.g., within a rescue center) could ensure diversity of behavior patterns and promote the performance of adaptive behaviors upon release to the wild.

KEYWORDS

animal welfare, environmental enrichment, waterfowl, wildfowl, wildlife rehabilitation, zoo

1 | INTRODUCTION

Environmental enrichment (EE) are techniques that enhance the environment within an enclosure or aspects of husbandry provided to captive animals to improve the biological relevance of behavior patterns and associated feelings of positive welfare (Newberry, 1995; Shepherdson et al., 1998; Young, 2003). Use of EE has become common in the husbandry and management used for animal species housed in human care (Alligood et al., 2017; Swaisgood & Shepherdson, 2005). EE has numerous beneficial outcomes, such as increasing behavioral diversity (Meagher & Mason, 2012), improving behavioral development (Salvanes et al., 2013), providing opportunities for positive challenge within a static enclosure environment (Meehan & Mench, 2007), and promoting positive welfare experience (Brydges et al., 2011). Individual animals housed in conservation projects benefit from appropriate use of EE to develop important behavioral skills that facilitate a successful life in the wild (Rabin, 2003; Reading et al., 2013). For wild individuals spending time in captivity within a wildlife rescue center (Escobedo-Bonilla et al., 2022; Monreal-Pawlowsky et al., 2017) or for juvenile life stages where behavioral flexibility and diversity is influenced by environmental and social interaction (Hyvärinen & Rodewald, 2013), appropriate use of EE can preserve or develop important survival skills. As animals in wildlife rescue and rehabilitation centers are destined to be returned to the wild (if deemed fit and healthy), the performance of adaptive behaviors that ensure survival needs to continue during the animal's stay in captivity. Changes to behavioral normality can be seen with increased time spent in a managed environment (Kelley et al., 2006) and this may be detrimental to individual survival. Therefore, use of EE to provide increased opportunities for positive behavioral diversity (e.g., increased time foraging) is beneficial to a future life back in a wild habitat. Specific signals of comfort or relaxation, for example wing flapping in domestic poultry, *Gallus gallus domesticus* (Zimmerman et al., 2011) could be used as indicators of good welfare when EE is present and therefore be a useful guide as to its efficacy and relevance for a given species.

Consequently, this research aimed to document how EE changed the behavior of captive individuals of a species commonly seen in a wildlife rescue center (the mute swan, *Cygnus olor*) to understand the positive effects of EE on behaviors whose performance supports survival in the wild.

The mute swan is a large species of wildfowl (order Anseriformes) and a candidate for the world's heaviest flying bird (Brazil, 2003; Johnsgard, 2016). In the United Kingdom, mute swans are generally territorial and sedentary when adult, although some colonial breeding is noted (Wieloch, 1991); they are a long-lived (up to 25 years) and long-breeding (into their 20th year) species (Johnsgard, 2016; Wieloch, 1991). Juvenile mute swans are sexually mature at 3 years of age (Coleman & Coleman, 2002), changing color from dark brown through to gray and white, to completely white at maturity (Conover et al., 2000).

Mute swans are common occupants of wildlife rescue and rehabilitation centers in the United Kingdom (Kelly & Kelly, 2004), due to ingestion of discarded lead, oiling of plumage, entanglement in and ingestion of discarded fishing line/hooks, malnourishment and traumatic injury (Cracknell, 2004; Pennycott, 1999; Routh, 2000), and are also the most commonly-housed swan species within captive wildfowl collections (British Waterfowl Association, 2022). EE for wildfowl is poorly researched, in spite of their ubiquitous presence in zoos and private facilities (Rose & O'Brien, 2020). Understanding wild behavior patterns can be useful for the development of relevant EE for captive individuals when attempting to promote adaptive behavior patterns (Newberry, 1995; Robinson, 1998; Salvanes et al., 2013). Consideration of hazards that a species faces out in the wild may provide further relevant information when designing captive EE, for example, to prevent unwanted injury or ingestion of foreign objects. Wild mute swans can require a large expanse of water with associated wet grasslands for foraging and rearing young (Gayet et al., 2011; Wood et al., 2013). A large proportion of their wild time-activity budget consists of foraging behavior (dabbling and up-ending to search for aquatic plant and animal material, as well as grazing) (Holm, 2002; Johnsgard, 2016; Tatu et al., 2007). Juvenile mute swans will spend more time feeding when in the presence of their parents than when they have become independent (Scott, 1984), suggesting that juveniles mature quickly upon independence into an adult-style foraging pattern. A lack of difference in juvenile and adult body condition, for swans in a rural environment, supports the idea that foraging is similar for independent juveniles and adult birds (Sears, 1989). Parent mute swans provide social support for their cygnets by maintaining a breeding territory where their young can grow and develop without interference from other swans (Scott, 1984) as well as guarding their cygnets against other threats too (Włodarczyk & Minias, 2015). The relatively long time period from cygnet hatching to fledging means that extensive parental care is required to maximize reproductive output (Włodarczyk & Minias, 2016).

Research highlights

- Enrichment for captive mute swans increased time spent foraging and swimming.
- Enrichment reduced time spent on inactivity and on preening.
- Further study into the most appropriate enrichment for waterfowl is recommended.

This case study aimed to determine the efficacy of EE on mute swan behavioral diversity, to illustrate any positive impacts of EE on behaviors important for maintenance and bird survival in the wild (e.g., foraging). It was predicted that a foraging-based enrichment device would increase time spent on food-searching activities and reduce time spent inactive (e.g., loafing and standing) as inactivity has been noted as common in other captive waterfowl populations (Rose et al., 2022). It was also predicted that EE would reduce time spent preening as this may be a redirected action in captive birds with limited opportunities for wider behavioral diversity (Bareham, 1976). It was precited that EE would decrease any performance of abnormal behaviors that may develop due to the predictable nature of the captive environment. Given that swans change their activity patterns with time of day (Keane & O'Halloran, 1992), temporal effects on behavioral performance were also considered. Finally, to understand how EE may promote good swan welfare (at a group level) in captivity, wing flapping rates were compared between baseline and enriched conditions as this action has been noted as an indicator of relaxation in other species of bird (Zimmerman et al., 2011).

2 | METHODS

Behavioral data were collected on two groups of juvenile mute swans housed at Swan Lifeline; a charity specifically engaged in the rescue and rehabilitation of mute swans. Observations commenced on December 19, 2021 and finished on December 29, 2021. The period of data collection was curtailed due to the outbreak of Avian Influenza in the United Kingdom at the time of the research schedule. Further types of EE were due to be tested but due to circumstances beyond the control of the researchers, this could not happen. Ethical approval was provided by the Ethics Committee of University Centre Sparsholt (UCSEC. 6121 December 7, 2021).

Fifteen juvenile (6–8 months old) mute swans of mixed sex, divided into two groups of nine and six individuals were observed for the study. All swans were of a similar size, with brown and white immature plumage, and were rescued over an 8-week period before the observations commencing. Each group lived in their own enclosure that contained a pool (cleaned and refilled daily), a concrete floor covered in rubber matting, wire mesh aviary sides, and wire mesh roof. Each enclosure contained a plastic food bowl that was used for grain. Birds were also provided with waterfowl pellet and vegetation that were placed directly in the pool once daily. A smaller enclosure "Pen 5" (that housed the group of six birds) was 9.8 m long by 6.2 m wide with a pool approximately 35% of the overall enclosure area. The group of nine birds had access to two enclosures ("Pens 6 & 7") that were both 8 m long by 5.7 m wide with a pond approximately 65% of the enclosure area. Husbandry routines (feeding, cleaning, and visual animal health checks) were completed in the morning before behavioral observations commenced to reduce any impact of bird management on behavior patterns.

2.1 | Behavioral data collection

Swans were categorized as group A (nine birds) and group B (six birds) for the purposes of analysis. Fourteen hours of captive data per group were collected at 10:00, 11:00, 12:00, and 13:00 for 1 h periods. Seven hours of data were collected for baseline (no enrichment) and enriched conditions per group. Fourteen hours were collected on the three wild juvenile swans at 11:00 and 12:00. A standardized ethogram (Table 1), developed during a pilot study that was completed on December 10, 2021, was used to define and describe swan behavior. Behaviors were scan sampled instantaneously at 1 min intervals (Bateson & Martin, 2021) with the number of birds performing a specific behavior on the sample interval recorded.

The same researcher (M. C.) recorded the behavior of all birds in both settings. Bird behaviors were recorded via a live CCTV link to the enclosure to prevent disturbance to the birds that may arise due to proximity of the observer.

2.2 | Enrichment design

The enrichment device used was a non-solid ball designed to prolong feeding times for pet dogs. This device was a 14 cm soft-rubber ball that contained many holes, and this was tested on December 10, 2021 to check the feasibility of the enrichment device and ensure there was no undue stress caused by a novel object in the enclosure. The ball was tightly packed with chopped lettuce and grass and floated in the main pool of the swans during EE observations. The vegetation presented to the swans in the enrichment device was taken out of their daily ration of grass and greenery that was provided for that day (i.e., it was not an extra on top of normal rations). Figure 1 shows the enrichment device being used by the swans. One enrichment device was provided to each flock in turn.

TABLE 1 Ethogram of mute swan behavior used for observational data collection.

Behavior	Description
Loafing	Inactive behavior with little or no active vigilance, such as resting, lying recumbent, or sleeping on land or floating on water.
Preening	Cleaning and rearranging feathers with bill or feet; bathing in water to clean feathers in a species-typical manner.
Wing-flapping	A bird stretches and flaps it wings repeatedly (whilst not in flight), either standing on land or whilst floating on water, to rearrange and redistribute plumage.
Walking	Terrestrial locomotion where the swan moves forward with one foot placed in front of the other.
Standing alert	The swan is standing on land, inactive but aware of its surroundings.
Swimming	Aquatic locomotion where the swan propels itself across the surface of the water by paddling its feet. The swan moves across the water's surface and is not searching for food.
Feeding	Direct consumption of food, either that provided as part of daily ration or that from the enrichment device.
Foraging	Dabbling at the surface of the water, up-ending for submerged food, actively seeking food on land, from the water's edge or in the water.
Drinking	Ingestion of water by tilting back bill and head.
Aggression	Antagonistic interactions (e.g., biting, pecking, chasing) between individual swans.
Captive-focused	Abnormal repetitive behavior such pacing (walking back and forth along a boundary) or biting and pecking at pool lining or matting within an enclosure.

FIGURE 1 CCTV-screenshot of swans using EE device in their pool (photo credit: M. Claydon/Swan Lifeline). EE, environmental enrichment. [Color figure can be viewed at wileyonlinelibrary.com]

2.3 | Data analysis

Due to a lack of ringing or immediately obvious individual-specific markings, it was not possible to record the behavior of each individual swan within the enclosures. Therefore, the average proportion of time spent on each behavior was calculated for each hour of observation for each date and condition. These average proportions of time spent on behavioral performance for each group (A and B) and all swan combined are presented in an overall activity budget to illustrate any differences between baseline and EE conditions. For the purposes of time-activity budget construction, feeding and foraging were presented together (as it was impossible to identify if up-ending swans were actively consuming food or simply searching for food).

Review of the activity budget was used to visually identify any potential effects of pen size (small or large) on baseline captive swan behavior, which may influence any influence of EE. The lack of individual recognition and repeated observations of the same subjects meant that repeated measures analyses were attempted when possible. All statistical analyses were conducted in RStudio v.2022.12.0 (RStudio Team, 2022) run using R v.4.1.0 (R Core Team, 2021).

2.3.1 | Analyzing individual behaviors

To analyze the relationship between provision of EE and of time of day on swan behavior, a linear mixed effects model was run in RStudio using the "lmerTest" package (Kuznetsova et al., 2017) with date and population (small pen, large pen, wild) included as random factors and time of day—categorized as morning (10:00 and 11:00), midday (12 noon), and afternoon (13:00)—and condition (baseline, enriched, wild) included as fixed factors. Model fit was assessed using the "MuMin" package (Barton, 2020) with the "r.squared (model name)" function used to calculate r^2 values. The "anova (model name)" function was used to generate test statistics, degrees of freedom, and *p* values once the model summary has been checked. The "car" package (Koster & McElreath, 2017) was used to check for variance inflation and therefore collinearity and any factors of a VIF > 2 were excluded from the model. After a first run of the model, neither time of day (morning, midday, afternoon) or pen (small or large) were significant predictors of any of behavioral outcomes and therefore these factors were dropped from the final model run. Outputs in the model summary were compared back to the baseline conditions to see if EE significantly affected the time spent on each behavior.

3 | RESULTS

Figure 2a shows that under baseline conditions, loafing, and preening were the commonest behaviors performed by these captive swans. EE increased time spent foraging and reduced inactive behaviors. Aggression and abnormal behaviors (captive-focused) constituted less than 1% of average time-activity budgets of these captive swans.

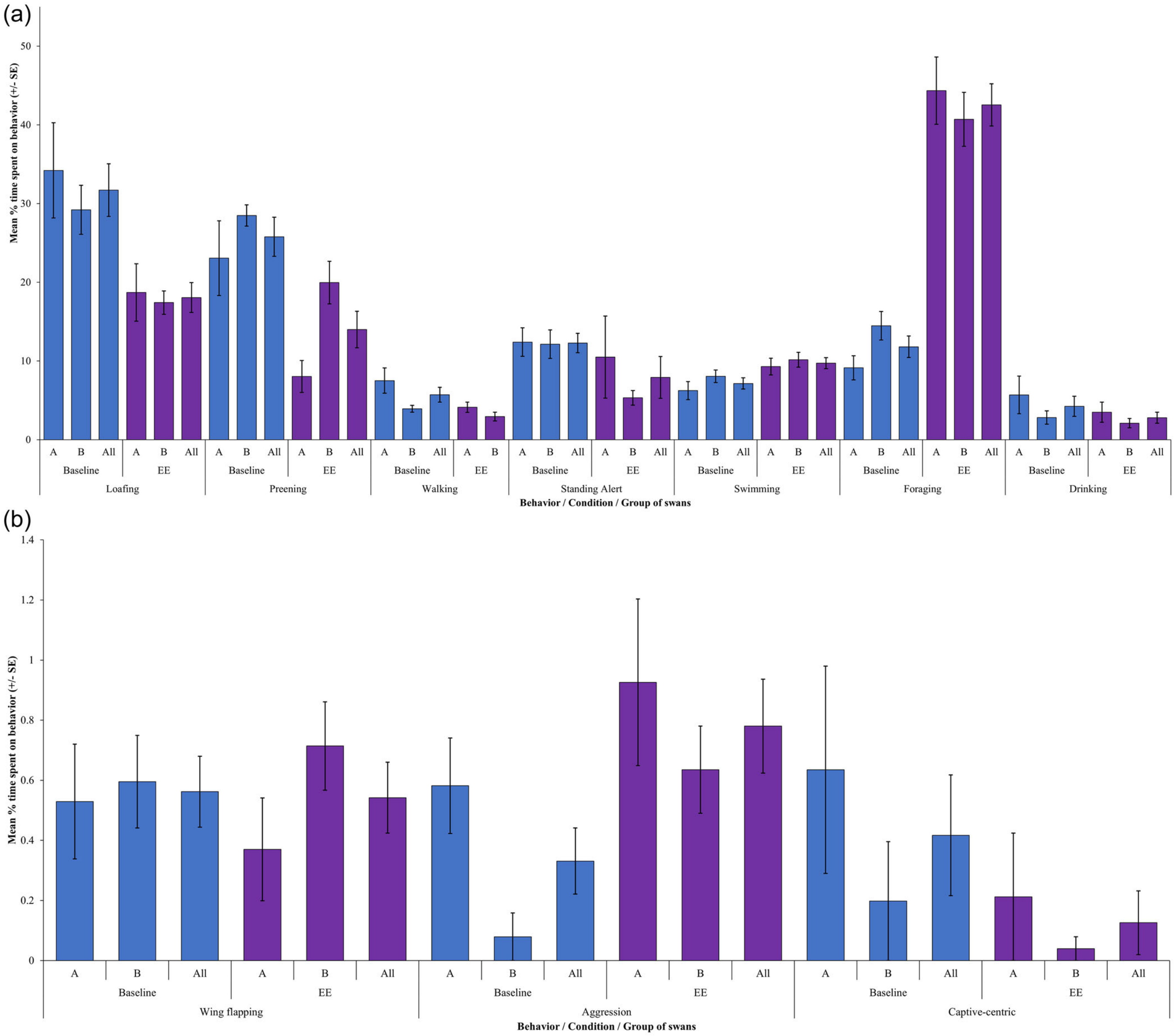

FIGURE 2 (a) Activity of mute swans when provided with EE compared to baseline conditions. Blue bars show mean % time (±SE) spent on behavior for the two groups of captive swans (A and B) and for both groups combined (all). Purple bars show mean % time on behavior for the captive swans when provided with enrichment. (b) Activity of mute swans (wing flapping, aggression, and captive-focused behavior) when provided with EE compared to baseline conditions. Blue bars show mean % time (±SE) spent on behavior for the two groups of captive swans (A and B) and for both groups combined (all). Purple bars show mean % time on behavior for the captive swans when provided with enrichment. EE, environmental enrichment. [Color figure can be viewed at wileyonlinelibrary.com]

Table 2 summarizes the model outputs for significant predictors of swan behavior.

Table 2 shows that EE increased foraging and swimming compared to baseline time budgets. EE significantly reduced time spent loafing, preening, and walking compared to baseline occurrences. Although, descriptively, standing alert appear to show a difference between baseline and enriched conditions (Figure 2a), this difference is not statistically significant but should be considered in future extensions to such work to further evaluate time spent on vigilance based on changes to environmental conditions.

Figure 2b shows that aggressive behavior was infrequently performed by this captive population (with and without EE) of swans and very infrequently performed by these wild juvenile swans. Time spent on aggression was significantly different between baseline and enriched conditions, with EE causing more instances of aggression between birds (Table 2). There was no impact of EE on occurrences of wing flapping or on CFB. Captive-focused behaviors (abnormal interactions with the environment) were rare to nonexistent in performance for these captive swans under baseline conditions, but such behaviors declined further (when performed) after the provision of EE (Figure 2b). This also opens a further avenue for study.

TABLE 2 Model estimates for baseline swan behavior is compared against behavior under enriched conditions.

Behavior	Factor	Estimate	SE	*df*	*t* Value	r^2	*p* Value
Foraging	Enrichment	0.307	0.03	26	10.23	0.80	<.001*
Loafing	Enrichment	−0.136	0.04	20	−3.62	0.35	.002*
Preening	Enrichment	−0.118	0.03	19	−4.11	0.57	<.00*
Wing-flapping	Enrichment	−0.0002	0.002	19	−0.13	0.18	.899
Walking	Enrichment	−0.022	0.01	25	−2.32	0.37	.029*
Swimming	Enrichment	0.026	0.01	19	3.28	0.53	.004*
Standing	Enrichment	−0.04	0.03	20	−1.54	0.13	.139
Drinking	Enrichment	−0.015	0.01	19	−1.25	0.43	.227
Aggression	Enrichment	0.005	0.002	19	2.65	0.40	.016*
Captive-focused	Enrichment	−0.003	0.002	19	−1.56	0.40	.136

Note: Model estimates for baseline swan behavior is compared against behavior under enriched conditions. Significant comparisons are highlighted with an asterisk.

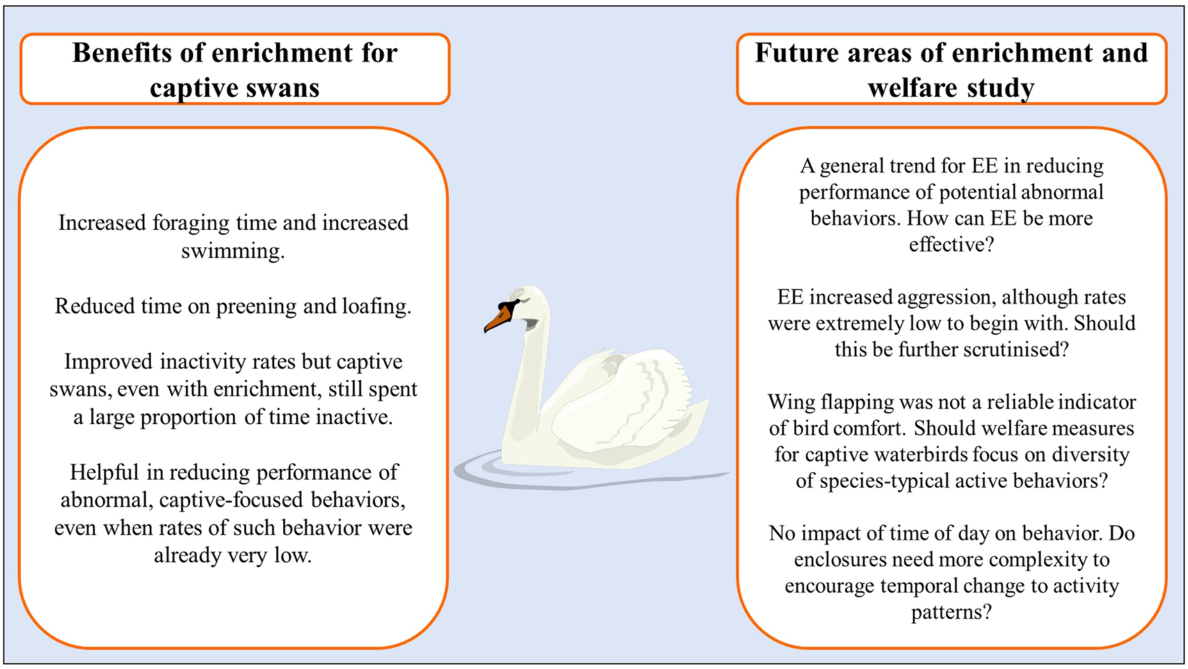

FIGURE 3 Summary of key outputs and potential future areas of study arising from this research project. [Color figure can be viewed at wileyonlinelibrary.com]

3.1 | Overall summary of results

These mute swans, when provided with EE, spent more time foraging and swimming, and less time on loafing, walking, and preening compared to baseline (Figure 3). This EE was not significantly effective in reducing performance of captive-focused behaviors. Therefore, our results allow us to support our prediction that foraging time would increase and certain inactive behaviors would decrease when captive swans are provided with EE. Our results showed that wing flapping rates are unaffected by EE and therefore further consideration of such behavioral indicators of welfare for captive waterfowl, and evaluation of their reliability, is needed.

4 | DISCUSSION

This research has identified that simple, easy-to-implement EE can improve activity patterns of captive swans in a rescue center environment. EE improves foraging time and increases the range of behavioral movements that swans can perform. Wild mute swans divert more time and energy to feeding compared to other behaviors

(Tatu et al., 2007) and our results showed an increase in foraging time of 30.7% (on average) between baseline and EE conditions, with a decrease in loafing 13.7% (on average) when EE was provided, suggesting that this EE was helpful in promoting naturalistic activity patterns. We recommend follow-up of released birds to see how foraging and locomotion rates compare for specific birds that have experienced captivity and then the wild. Rates of captive-focused behaviors were extremely low in performance overall (Figure 2b). Although performance of these abnormal behaviors reduced in the presence of EE, showing a general trend, there was no significant difference in captive-focused activities with and without EE.

Our research mirrors that found by others whereby captive swans appear to be markedly inactive (Guyon, 2009), especially when compared to wild birds. Whilst some inactivity is beneficial, birds in a managed environment need to be provided with outlets for adaptive behaviors to be performed—particularly if captivity is temporary and birds are due to be released to the wild. Our research identified that more evaluation of long-term inactivity is needed for captive waterbirds specifically, and in captive animals generally, as high rates of inactivity may result in future pathological conditions or be suggestive of boredom (Fureix & Meagher, 2015). Increased rates of beneficial exercise improve animal welfare (Miller et al., 2016), therefore in the case of swans, encouraging on-water foraging (and an associated time spent on swimming) could help individual improve physical and psychological health. As mute swans are amongst the heaviest of all birds (Reynolds, 1972), flooring and substrate type and chronic inactivity should be considered from a health and well-being perspective. In other species of bird, the amount of time spent stationary in captivity can predispose individuals to pododermatitis (Reissig et al., 2011; Wyss et al., 2013). Heavy-bodied birds in small enclosures with restricted movement are more likely to develop foot lesions (Faux & Logsdon, 2022; Sander et al., 2013). As this EE increased the time that swans spent swimming and reduced time spent walking on land, there are likely to be leg and joint-related health benefits that could reduce the propensity of captive swans to develop pododermatitis. Encouraging swans to swim reduces the amount of time spent applying pressure to the feet, and improves the condition of the plantar surface of each foot (Routh, 2000). In other species, exercise that encourages circulation to the legs and toes helps reduce the severity of pododermatitis (Samour et al., 2021), potentially due to improved circulating immunoglobulins.

Swimming time may be related to husbandry practices (e.g., the provision of food encouraging birds to move around) and in our research, is likely connected to the EE being placed in the pool. Further data collection across different times of the day—for example, later afternoon and evening when other species of swan become more active (Hamilton et al., 2002)—would be helpful to determine changes in pool usage over time and therefore when EE should be provided to further improve behavioral diversity. Many species of waterbird are known to increase loafing and resting during the middle of the day (Ringelman & Flake, 1980) and therefore the restricted times of observation for these mute swans may not have provided a complete picture on the changes in swan activity in this captive setting.

Although pen size was not a significant influence over behavior in this study, there are differences in time spent on behaviors between the two groups (Figure 2a,b). Enclosure size and pool space may be a limiting factor on the amount of time spent swimming and any social dynamic may impact on how individual birds can use a pool. As has been noted in captive penguins (Sphenisciformes), changes to a birds' overall enclosure to increase the naturalism of an enclosure increases time spent in water and time spent on positive social behaviors (Fuller et al., 2023). Therefore, an extension of such a project should follow individual swans when housed in enclosures of a different size to be able to fully determine the effect of enclosure size on bird activity. Although our results suggest a limited effect of enclosure/flock size on swan activity, for example, similar mean times for loafing and standing alert, and for swimming, a combination of the pool size and number of swans may have caused individual swans to cope differently with the captive set-up. The methods employed by this project have not been able to capture any individual responses to captivity. Higher rates of preening that were observed in the smaller group of swans in the smaller enclosure may indicate discomfort. Close proximity of conspecifics increases preening, which is a displacement activity in other avian species (Henson et al., 2012) to cope with social stress and disturbance from the presence of other individuals. Therefore, we recommend further research into such the relevance of such potential behavioral indicators to welfare assessment protocols of captive waterfowl.

Wing flapping indicates relaxation in domestic fowl, as an increased performance of wing flapping precedes pleasurable activities (Zimmerman et al., 2011). Although we found no significant difference in rate of wing flapping with and without EE, further study into this behavior as an easily observable welfare indicator is recommended. Observing the sequence of wing flapping and preening around interaction with EE may provide insight into the psychological well-being of the swans. Individual measures of behavior and a longer period observing preening and comfort behavior would also reveal more information on the suitability of such EE for captive swans. Reduction in time spent preening in this study, clearly show that provision of EE provides an extra outlet for behavioral motivation (e.g., foraging actions or exploratory behaviors) that could manifest as over-preening in birds that are housed in an environment that limits overall positive behavioral diversity.

Aggression may have increased with EE due to the closer proximity of swans to each other around a valued and limited resource. Low rates of aggression in the wild are likely caused by the expanse of the habitat, the small group of related birds and the presence of no other swans in the area. Some authors recommend assessment of swan temperament when mixing birds together to prevent overt aggression (Routh, 2000) and if EE does increase social interactions, knowing how birds are likely to response to each other (via previous temperament assessment) may provide a securer and safer captive setting for each individual swan. Mute swans are known to be nervous in strange environments (Routh, 2000) and therefore use of EE could help birds to settle into a new facility or population by distracting other birds (reducing chances of aggression) as well as providing opportunities to interact with the bird's surroundings in a positive way that enables acclimation to occur more quickly.

Swan aggression with EE showed a significant difference between the enriched condition and baseline because EE is valuable and provided in a limited, fixed amount. Under the baseline condition, aggression rates were lower because there were no valued resources to compete over. The biological meaning of our statistical outputs for aggression needs to be evaluated considering the already very low rates of its performance. Consequently, our significant findings for differences in the performance of aggression are unlikely to represent actual biological significance in amount of time spent on aggression within the swan's activity pattern. However, we would recommend practitioners consider use of multiple EE items for future swan enrichment schedules to further reduce heightened levels of aggression that may center around food.

5 | CONCLUSIONS

Captive mute swans housed in a wildlife rescue facility benefitted from the presence of EE and performed more foraging behavior and spent less time on preening and loafing (inactive) behavior compared to baseline conditions. Although change in captive-focused behavior between baseline and EE conditions was not significantly reduced (Figure 2b), a general trend in already low rates of such abnormal behaviors suggests that more regular EE and an increase in the number of EE devices could potentially eliminate abnormal repetitive behaviors in these captive swans. As research on wild mute swans shows that most of their time to be spent on foraging, further research into the design and implementation of effective EE regimes for this species, which is common in rescue centers and zoological collections, is recommended to help promote widespread improvements in swan time-activity budgets and potentially in swan health and well-being too.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The raw data set from this project is available at this link: https://figshare.com/articles/dataset/Untitled_Item/24156789.

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