NOTE FROM THE EDITOR

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Dear Friends, Colleagues and Otter Enthusiasts!

So finally, we start the year 2021 with the opening of the first issue of this year. I do hope that all of you are safe and healthy, and that we will see an improvement of the situation thanks to the vaccinations starting. We all have experienced travel restrictions and I can only imagine how this must have affected those working in the field.

This is the first issue in 2021 and it is with great pleasure that I can announce that in fact we have material for 3 issues already waiting to go online. Lesley has made great efforts to reduce the backlog that we had accumulated, and we hope to reach in a few months the point that we have no backlog at all. From that moment on articles will go online the very moment they are accepted and the proofprint was seen and approved by the authors.

Again I want to use the opportunity and express my special thanks to my always supportive translators Gerard Schmidt and Claudio Chehebar for their very fast work with the increasing number of translations of the abstracts into French and Spanish. Thank you for often spotting final inconsistencies in the articles too. Merci! Gracias!

My sincere thanks go to Lesley for all the private efforts and hours spend with getting manuscripts online and the extra work to double-check the manuscripts for typos and the one always missing reference.

A R T I C L E

OUTDOOR ENCLOSURE USE AND BEHAVIOUR OF ADULT AND CUB ASIAN SMALL CLAWED OTTERS *Aonyx cinereus* IN SUMMER AND WINTER

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Abstract: The behaviour and outdoor enclosure use of a family of *Aonyx cinereus* otters were investigated in summer and winter at the Wildfowl and Wetland Trust Washington center, UK. In summer, swimming and paddling (adults and cubs) and diving (adults) were recorded significantly more frequently than in winter, correlated with significantly higher frequencies of use of the water features. For the cubs, the relative frequency of diving was significantly lower compared to winter, as the cubs were still learning to swim and forage underwater. The levels of activity and the diversity of behaviours were higher around feeding times in both seasons. The cubs were already swimming in shallow water at 3.5 months-old and in deeper water at 4.5 months-old, mostly as a family group. At 3.5-6 months-old they were out of sight in the den significantly more frequently than the adults and displayed more play-fighting. By 8-9.5 months-old they moved around independently, foraging or playing and their behavioural budget was similar to that of the adults. Object juggling and vigilance standing were displayed from around 4 months-old, when weaning also occurred. The introduction of additional structural enrichment (logs, holt, nest-box) in early autumn increased the frequency of use of ground areas in winter, when the water temperatures were below 10 °C. The feeding and structural enrichment strategies used were effective for keeping the otters active outdoors and maintaining their high display value in the cold season (day time summer air temperatures 15-27 °C > winter 3.5-10 °C), emphasizing the importance of enrichment for good welfare.
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INTRODUCTION

Asian small clawed otters (ASCO) have been listed as Vulnerable on the IUCN Red List since 2008 and are at risk of becoming extinct in some regions in central Asia due to extensive habitat loss, water pollution and exploitation by humans (Wright et al., 2015). Field surveys suggest that the global population of ASCO has declined by more than 30% over the last 30 years (Wright et al., 2015) and their geographical range is predicted to shrink by 17-41% by 2050 due to loss of suitable climatic areas (Cianfrani et al., 2018). Their current range covers a large part of southern and south eastern Asia and includes diverse habitats, ranging from coastal and freshwater wetlands to paddy fields, rivers and lakes in forested areas at higher altitudes (Rosli et al., 2014). Their increased popularity on social media led to an increase in illegal pet trade (Kitade and Naruse, 2018; Harrington et al., 2019) and the species has been recently moved from CITES Appendix II to Appendix I (CITES, 2019).

The ASCO Survival Plan (Foster-Turley, 1986) encouraged more research into reproduction in captivity, to support the increased conservation efforts *in situ* and ensure long-term survival of the species both in captivity and in the wild (Bateman et al., 2009). ASCO adapt well to living in zoos and aquaria and are the most common captive otter species in the United Kingdom (Wright, 2003) and in many other countries outside their natural range (Kruuk, 2006). They are reproductively active all year round, with mating lasting for up to 30-45 minutes and occuring mostly in shallow water (Reed-Smith and Polechla, 2002; Heap et al., 2008). Reproductive success varies, with no offspring produced in some zoos (Foster-Turley, 1990). Various zookeeper accounts (AZA, 2009) and a recent quantitative study showed that ASCO spend more time swimming in warmer water (Cuculescu-Santana et al., 2017). As tropical warm-adapted mammals, they have a significantly higher metabolic rate in cold water compared to other otter species (Borgwardt and Culik, 1999), possibly due to poorer insulative capacity of the fur and skin and greater heat loss over the whole body surface compared to the cold-adapted Eurasian otter *Lutra lutra* and similar in pattern to that of another tropical species, the giant otter *Pteronura brasiliensis* (Kuhn, 2009; Kuhn and Meyer, 2009).

Many North American zoos keep ASCO in climate-controlled environments with ambient temperatures of 21-23 °C, while some institutions heat only the pool water, or keep the otters mostly inside a heated indoor shelter during the cold season (Reed-Smith and Polechla, 2002). The majority of zoos in Europe reported housing ASCO in outdoor enclosures with water features or in indoor-only enclosures, without giving specific details of climate-control (Dornbusch and Greven, 2009). The recommended temperatures for ASCO are 22.2-24.4 °C for air and 18.3-29.4 °C for water and the otters usually cope well with lower temperatures, even below 10 °C, provided they have dry shelter and a source of radiant heat in the cold season (Heap et al., 2008). However, activity levels were lower and the frequency of abnormal repetitive behaviours (ARBs) was higher in the cold season, in correlation with the increased energetic demands of thermoregulation (Cuculescu-Santana et al., 2017).

Although no single factor was identified to have a strong correlation with successful reproduction of ASCO in captivity (Reed-Smith, 1998), maintaining well-balanced energy budgets by manipulating the enclosure temperatures and feeding strategies represents an important aspect of otter husbandry (Heap et al, 2008). The introduction of other types of environmental enrichment to stimulate naturalistic active behaviours such as swimming, foraging and social play can also have an important role in fostering high welfare and increasing the likelihood of successful cub birth and development to adulthood (Hussain et al, 2011). In captivity, both parents look after the cubs, often with help from older siblings (Nair and Agoramoorthy, 2002). Cub development from birth to weaning is well documented for captive otters and seems to reach a critical stage around 14 weeks old, when weaning usually begins (Timmis, 1971; Prima, 1992; AZA, 2009). Several cub deaths around this time were reported in the earlier scientific literature, due to inability to progress acquiring solid food (Leslie, 1971; Lancaster, 1975; Sivasothi, 1998) and in some cases labour-intensive hand-rearing interventions were required (Webb, 2011). There are very few descriptions of ASCO cub behaviour beyond this stage (Owen, 2004; Wright 2005; Lemasson et al., 2014), as they become gradually more independent of their parents, and not much is known about what happens in the wild (Kruuk, 2006).

The initial aim of this study was to investigate the influence of seasonal variations in temperature on the behaviour of a pair of ASCO in an outdoor enclosure at the Wildfowl and Wetland Trust (WWT) Washington (England) and the effectiveness of adding new structural enrichment at keeping the otters active during the cold season. The range of temperatures experienced in the outdoor enclosure was expected to be broader than that experienced by the ASCO studied in an indoor enclosure at a different establishment in 2013 (Cuculescu-Santana et al., 2017) and lead to greater differences in levels of activity between summer and winter and in the use of water features. However, the existing feeding strategies and the new structural enrichment were expected to sustain the otters' interest in exploring the outdoor areas during the colder season, keep them active and maintain their display value (AZA, 2009). The pair had already reproduced successfully in spring 2015 (one female cub), and the arrival of a new litter of four cubs in March 2016 offered the additional opportunity to study cub behavioural development from 3.5 to 9.5 months old.

METHODS

Otters, Enclosure and Enrichment

The family of ASCO studied consisted of the adult pair (captive born 6-years old male and 5 years-old female, around 3 Kg weight), a 1-year old female cub (fully grown), and four new cubs (3,1) born in March 2016 (Figure 1). The otter enclosure (approximately 400 m^2 surface area, 5:1 land:water) had a variety of natural substrates outdoors (soil, grass, vegetation, bark chippings and sand) (Figure 2) and structural enrichments (several logs and tree stumps, tunnels, river and three pools with filtered recirculating water, ranging from 0.2-0.5 m depth) as well as a split-level den with a heat lamp (Figure 3).

(a)

(b)

(c)

Figure 1: The family of otters at the WWT Washington Centre, UK: (a) Adult otters, Musa (M) and Mimi (F) (*Photo Copyright: Mirela Cuculescu-Santana*); (b) 1-year old cub, Ruby (F) (*Photo Copyright: WWT*); (c) Otter cubs, born 3/03/2016: Ash (F), Tod, Pip and Sam (M) (*Photo Copyright: Ian Greneholt*)

The otters were fed four times a day (9:00 am, 11:30 am, 3:00 pm and 5:30 pm), on a varied diet of fish, shellfish, day-old chicks and red meat, boiled eggs once a week and chopped vegetables (approximately 600g/ adult otter/ day in total, all year round). Feeding enrichment strategies included varying the form of delivery of the main feeds (scattered or hidden in different areas of the enclosure, to encourage foraging, or keeper-fed during training; food hidden inside larger vegetables, etc.) and the type of food. Public talks took place twice daily, combined with the 11:30 am and 3:00 pm feeds (Washington Wetland Centre, 2016). New structural enrichments were added to the back area and the low end area in early autumn 2016 (Figure 4 a, b) and more space was created around an existing logs structure in the back area (Figure 4 c).

(a) (b)

Figure 2: The otter enclosure at the WWT Washington Centre, UK: a) Den and outdoor area with structural enrichments and natural vegetation (*Photo Copyright: Mirela Cuculescu-Santana*); b) Aerial view (Google Maps, 2016).

(a) (b) (c)

Figure 3: Closer view of some of the structural enrichments in the otter enclosure at WWT Washington: (a) Tall tree stump with climbing 'steps' and tunnels in the base; ladders and platform around the entrances to the den; (b) Training area with seven logs; (c) Vegetation and stone structures around river mouth and shallow pool (*Photos Copyright a-c: Mirela Cuculescu-Santana*).

(a) (b) (c)

Figure 4: New structural enrichments added to the back area and low end area of the otter enclosure before winter 2016: (a) nest box; (b) small holt and (c) logs structure at the back of the enclosure and nest box; trimmed vegetation gave better access to the logs structure (*Photos Copyright a-c: Mirela Cuculescu-Santana*).

Data Collection

Data were collected in summer 2016 (June-August; temperatures: air 15-27 °C, water 15-25 °C) and winter 2016 (November-December; temperatures: air 3.5-10 °C, water 3.5-8 °C) on mostly dry days (occasional light rain; no persistent snow cover in winter 2016).

The behaviour and the enclosure use were recorded on five different days in each season, using continuous observation and scan sampling, with one-zero recording rule for every 2-minutes interval (Rees, 2015), for 5.5 hours each day (10:30-16:00), split into 30 minutes observation periods (5 days x 11 observation periods per day x 2 seasons = 110 data sets in total, for each age group) by the same observer, separately for the adults and for the 2016-born cubs, using the ethogram shown in Table 1 and the coding system and grouping for the enclosure zones shown in Figure 5. At the same time, a second observer used instantaneous time sampling every 30 seconds to record the time spent in the water by the adult male and the female 2016-born cub.

The approximate visitor numbers were also recorded for each 2-minute interval using a ranked score from 1 to 5 (1 = only 1-2 people present; 2 = 3-4 people; 3 = 5-10 people; 4 = 11-20 people; 5 = more than 20 people). Air and water surface temperatures were recorded daily using a hand-held INFRARED DT8550 thermometer.

Table 1. Asian small-clawed otter ethogram (Adapted from Cuculescu-Santana et al., 2017). Asterisks represent categories and behaviours that may include abnormal repetitive behaviours.

Category	Behaviour	Description of Behaviour
Land Locomotion	Walking, Running & Climbing	Faster or slower locomotion on the ground, on other flat structures or climbing on higher structures, with head up.
Swimming and Paddling	Swimming, Paddling	Locomotion in deep or shallow water, with head out of water.
Diving	Diving	Locomotion in deep or shallow water, with head under water; Foraging in the water.
Foraging and Digging	Foraging, Digging	Moving on land with the head down and the nose close to the ground; Using paws to move vegetation, dig into substrate or claw at a wooden structure.
Scent Marking	Scent rubbing, Sprainting	Rubbing a body part against a substrate or structure; Urination or defecation; Spreading faeces with the tail
Play Fighting	Social play	Chasing and tumbling together on land or in water.
Social Affiliative	Body rubbing, Social grooming, Food sharing, Parental care, Sexual behaviour, Keeper interaction	Close body contact; Using paws or mouth to clean, dry or smooth the fur of another otter; Giving food to another otter; Suckling, nudging, carrying cub; Adults holding on to each other and rolling around in or out of water, in close body contact; male chasing and mounting the female; Watching, following, nudging, biting keeper.
Aggression*	Fighting, Biting*, Snorting, Snarling	Rough fighting, with biting, shoving, hair plucking and/or scratching; Aggressive displays towards other otters.
Eating and Drinking	Eating, Drinking	Biting, chewing, handling food; Drinking water;
Solitary Activity*	Self-grooming, Playing with object, Pacing*, Abnormal behaviours*, Yawning	Using paws or mouth to clean, dry or smooth own fur, or rolling on grass or sand; Handling an object other than food (pebble, shell, straw, twig, enrichment item); Moving repetitively along the same route; Head flips, tail sucking or biting, etc.; Opening the mouth wide to take in air (presumed involuntary action).
Vigilance*	Looking around, Standing on hind paws, Begging*	Being alert and looking around from four-paws position, with head up; or Turning in a circle to scan surroundings*; Standing on hind paws to look around; Performing repetitive up-down ‘begging’ displays*.
Vocalising	Short calls*, Long squeals, Soft calls	Short, sharp and loud squeals; Longer and higher pitched loud sounds; Low intensity squeaks, chirps and chuckles.
Resting	Resting	Lying down with head down outside

Out of Sight	Out of sight	Being inside the den or holt or hidden in the vegetation.

Data Processing and Data Analysis

The behaviour and enclosure use data collected using scan one-zero sampling were processed as frequency of recording of each behaviour and each enclosure zone per observation period, grouped into behavioural categories (Table 1) and enclosure zones (Figure 5) and converted into percentages of all behaviours/locations recorded per observation period. The duration and the number of bouts of sexual behaviour and of swimming were calculated for each season. Visitor data were processed as average scores per observation period.

Average relative frequencies (%) were calculated for each age group, season and time of day. The data for cubs were also averaged by cub age in months, from 3.5 to 9.5 months-old. Non-parametric tests of difference were carried out in SPSS V26, at level of significance $P<0.05$ (Mann-Whitney U-test for differences between summer and winter and between adults and cubs; Kruskal-Wallis Test for the influence of time of day and cub age). The seasonal influence on the frequency of swimming bouts of each duration was tested using Pearson's two-way Chi-square test in Microsoft Excel.

Ethical Considerations

The project received ethical approval from the Ethics Commission of Northumbria University and was carried out with consent from and in collaboration with the Collections Manager and the Keepers at the WWT Washington Wetland Centre. The data were collected from outside the enclosure, without any direct interaction between observer and otters.

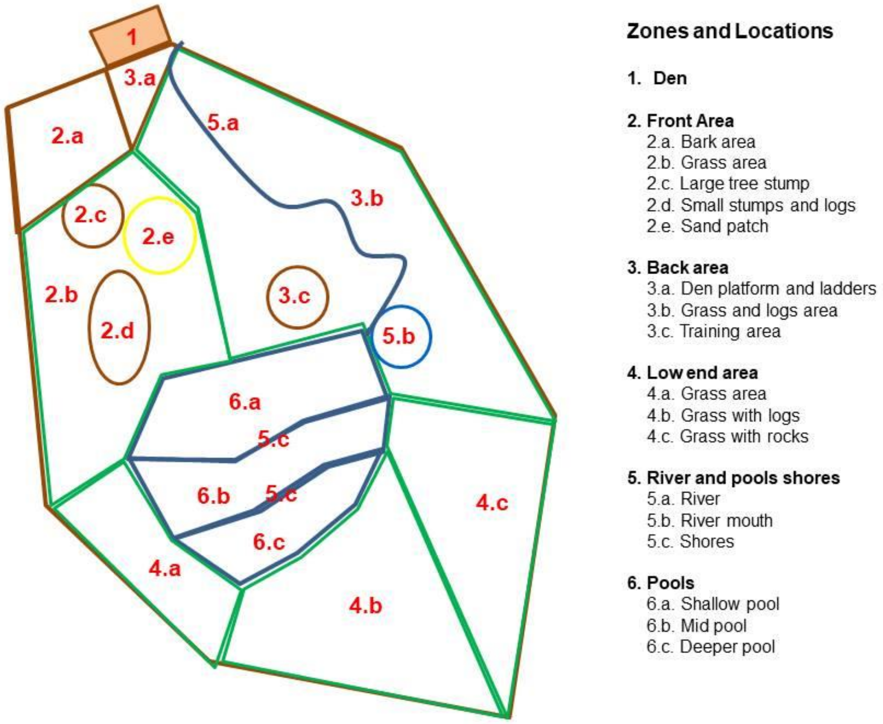


Figure 5. Diagram of the otter enclosure at WWT Washington with zone coding and description

RESULTS

Seasonal and Enrichment Influence

The behaviour and enclosure use of both adult otters and otter cubs were significantly influenced by seasonality (Figures 6-8). The air and water surface temperatures recorded in winter were lower than those recorded in summer (Figure 6). For the adults, swimming and paddling (7.1% > 2.9%; Z = -3.352; $P<0.01$), diving (5% > 2.6%; Z = -2.439; $P<0.05$) and resting outside (2% > 0.3%; Z = -2.321; $P<0.05$) represented a significantly higher percentage of all behaviours recorded in summer, compared to winter (Figure 6a). Similar differences between summer and winter were observed for the cubs for swimming and paddling (5.5% > 2.9%; Z = -1.990; $P<0.05$) and for resting outside (1.3% > 0.2%; Z = -2.656; $P<0.01$), while diving was significantly more frequent in winter (2.6% > 1.9%; Z = -2.361; $P<0.05$) (Figure 6b). Swimming bouts of 4 minutes or more occurred significantly more frequently than expected in summer than in winter ($P<0.001$; $\chi^2=37.216$), when the majority of swimming bouts lasted 1 minute or less for both the male adult and the female cub (Table 2). Social affiliative behaviours were also more frequent in summer for the adults (8.6% > 5.2%).

For adults, the largest increase in relative frequency from summer to winter was seen for being out of sight (25.8% < 34.3%; Z = -2.803; $P<0.01$) (Figure 6a) A small increase was seen for out of sight for cubs (35.4% < 37.4%) (Figure 6b). In summer, eating frequently took place in shallow water, immediately after finding a piece of food, while in winter the otters foraged in the water but usually ate out of water (Figure 7).

In summer, the adult otters were seen diving (5% > 1.9%; Z = -3.860; $P<0.001$) and displaying social affiliative behaviours (8.6% > 4.7%; Z = -2.468; $P<0.05$) significantly more frequently than the cubs. The cubs were out of sight significantly more frequently than the adults (35.4% > 25.8%; Z = -2.198; $P<0.05$) and engaged in play fighting more frequently than the adults (3.5% > 1.4%). Similar differences between adults and cubs were seen in winter, but of much smaller magnitude (Figure 6).

The differences in behaviour between summer and winter and between adults and cubs were also reflected in the differences in enclosure use. Both adults and cubs used the pools (adults Z = -3.309; p<0.01; cubs n.s.) and the front area (adults Z = -2.970; $P<0.01$; cubs Z = -1.980; $P<0.05$) more frequently in summer than in winter. In winter, both adults and cubs used the den (adults Z = -2.158; $P<0.05$; cubs n.s.), the back area (adults Z = -4.736; $P<0.001$; cubs Z = -3.976; $P<0.001$) and the low end area (adults Z = -3.957; $P<0.001$; cubs Z = -4.601; $P<0.001$) more frequently than in summer (Figure 8), (n.s. = not significant at $P<0.05$ level).

Activity Patterns

In both seasons, the otters were more active and displayed a greater variety of behaviours just before, during and just after feeding times (Figures 9,10 for adults, very similar patterns for cubs, not shown). Land locomotion, swimming, vigilance and vocalisations increased just before feeding times, while behaviours such as eating and drinking, foraging and digging and diving increased during feeding, as expected. Aggression was also recorded more frequently during feeding. Play fighting and other social affiliative behaviours (eg grooming, body rubbing) and solitary behaviours (self-grooming, playing with objects) increased in frequency during the 30-min intervals just after those during which feeding occurred. The frequency of recording of many behaviours was significantly influenced by time of day, especially in summer (Kruskal-Wallis test, *P*<0.05 level of significance; see captions of Figures 9-10).

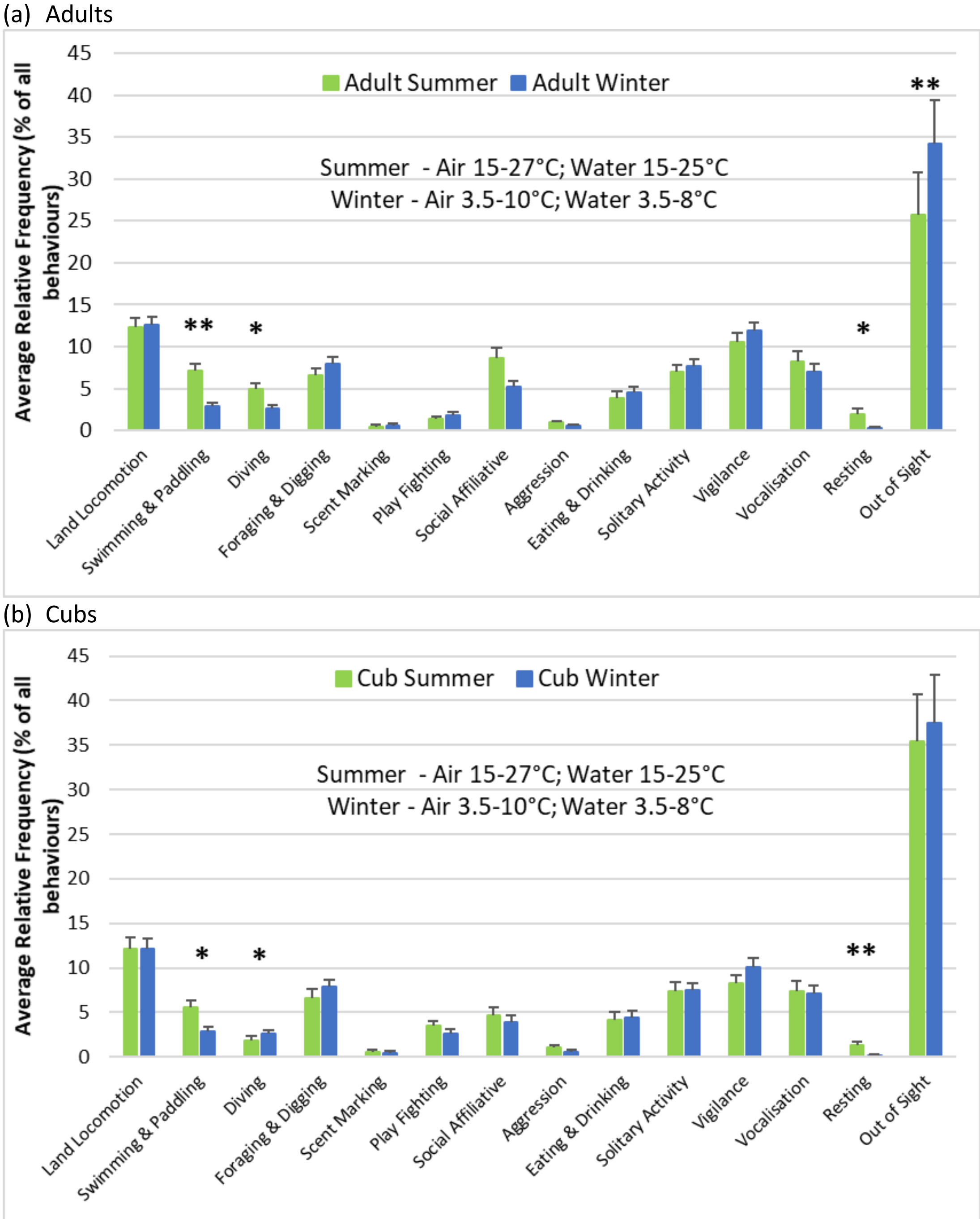


Figure 6: Seasonal behavioural budgets: (a) adult otters; (b) otter cubs: average relative frequencies (% of all behaviours recorded in an observation period), standard errors of the sample means, n=55. Asterisks denote statistical significance at $P \leq 0.05$*, $P < 0.01$** (Mann-Whitney U test).

Table 2: Seasonal influence on the duration of swimming bouts and the frequency of bouts of different lengths for the adult male and the female 2016-born cub (focal data).

Otter	Duration	Summer (Nº of Bouts)	Winter (Nº of Bouts)	Outcome Chi-Square Test
Adult	0.5-1 min	8	26	P < 0.001
	1.5-3.5 min	10	6	
	4 min or more	28	0	
Cub	0.5-1 min	19	34	P < 0.001
	1.5-3.5 min	12	3	
	4 min or more	35	0	

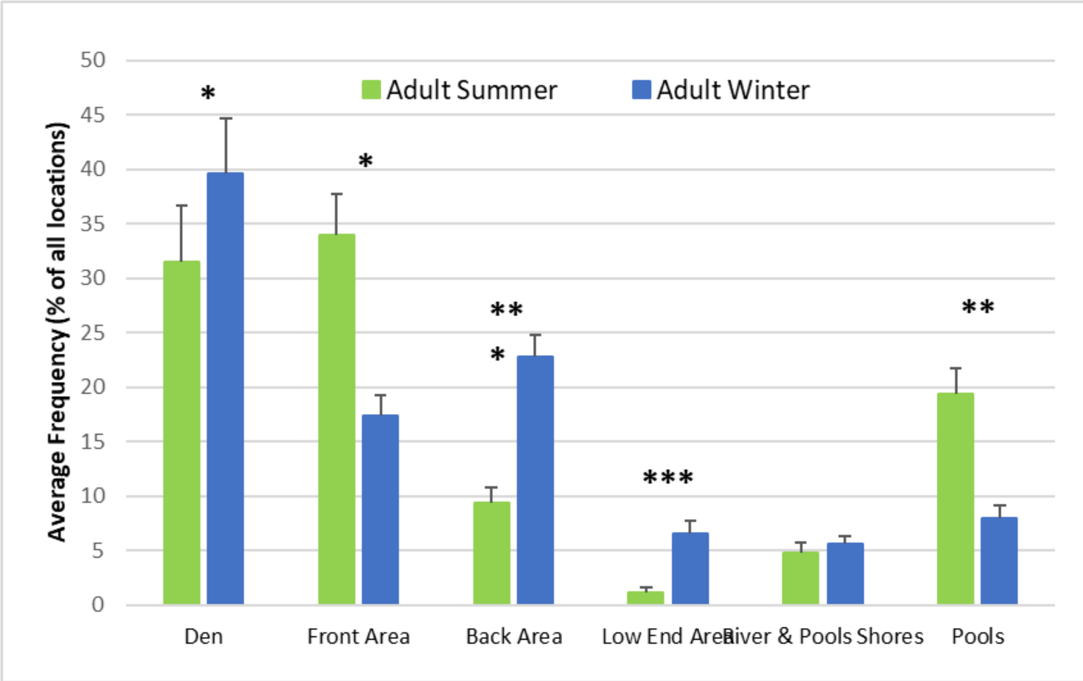
(a) (b) (c)

Figure 7: Seasonal changes at WWT Washington: (a) summer: swimming, diving, foraging, eating and playing in the water; (b) winter: eating out of water, on the mid pool shore; (c) winter: eating out of water, on the pool shore at the low end of the enclosure (*Photos Copyright a-c: Mirela Cuculescu-Santana*)

The peaks in otter activity around the two feeding times that occurred during the data collection intervals (the second feed of the day at 11:30 am and the third at 3:00 pm) were also associated with peaks in visitor numbers (Figure 11).

This pattern was more consistent in the summer, when all otters were inside the den for around one whole hour, which included the 1:00-1:30pm interval on all five days of data collection, with the exception of one instance of social affiliative behaviour recorded for the adults. In winter, the timing and the duration of the period of rest between the feeds was more variable, with one or both adult otters being out of sight inside the den more frequently than in the summer throughout the day, and with the otters at their most active later in the day, around the 3:00pm feed (Figure 10).

a)



b) Cubs

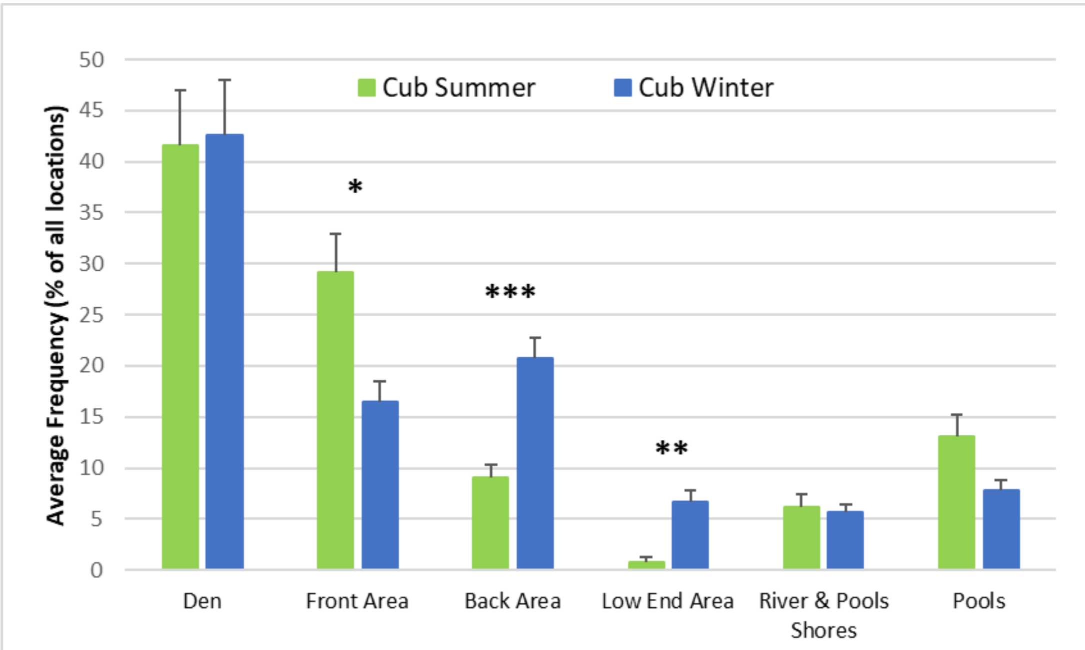


Figure 8: Seasonal enclosure use budgets: (a) adult otters; (b) otter cubs: average relative frequencies (% of all behaviours recorded in an observation period), standard errors of the sample means, n=55. Asterisks denote statistical significance at $P \leq 0.05$*, $P<0.01$**, $P<0.001$*** (Mann-Whitney U test).

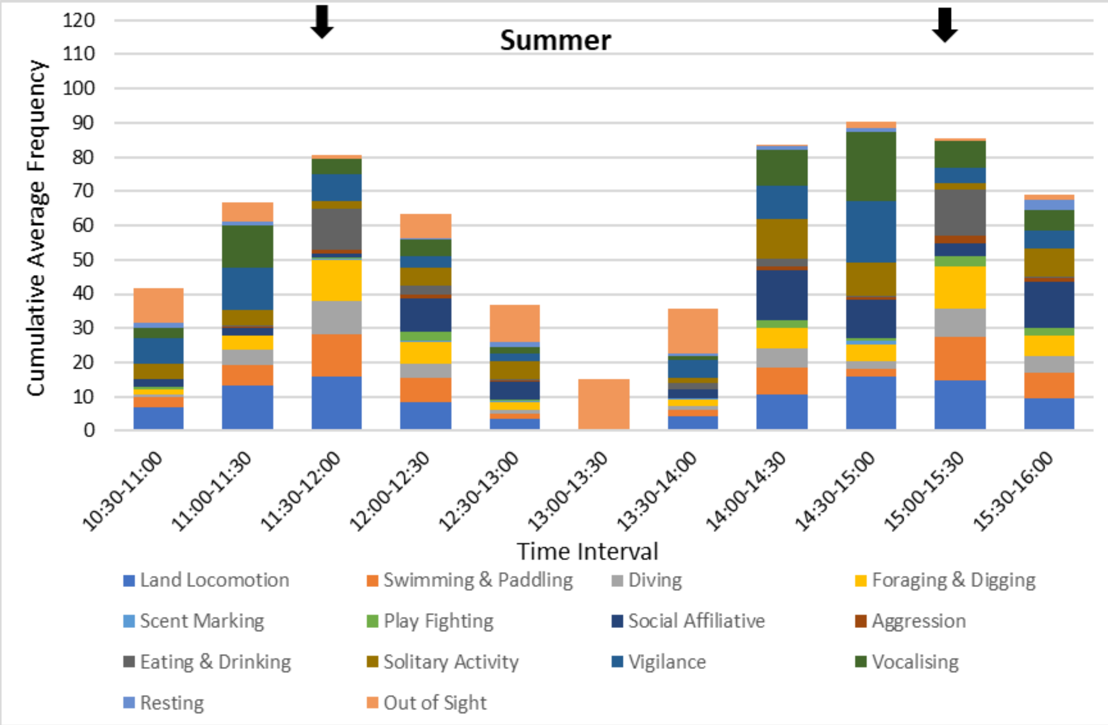


Figure 9: Day time activity pattern for the adult otters in summer. Arrows represent feeding times. Values represent average frequencies of recording for each behavioural category and each time of day (n=5). Outcomes of Kruskal-Wallis test for influence of time of day: Aggression*, Diving **, Eating & Drinking***, Foraging**, Land Locomotion**, Out of Sight***, Playing*, Social Affiliative**, Solitary Activity**, Swimming***, Vigilance***, Vocalisation**. Asterisks denote statistical significance at $P \leq 0.05$*, $P < 0.01$**, $P < 0.001$***.

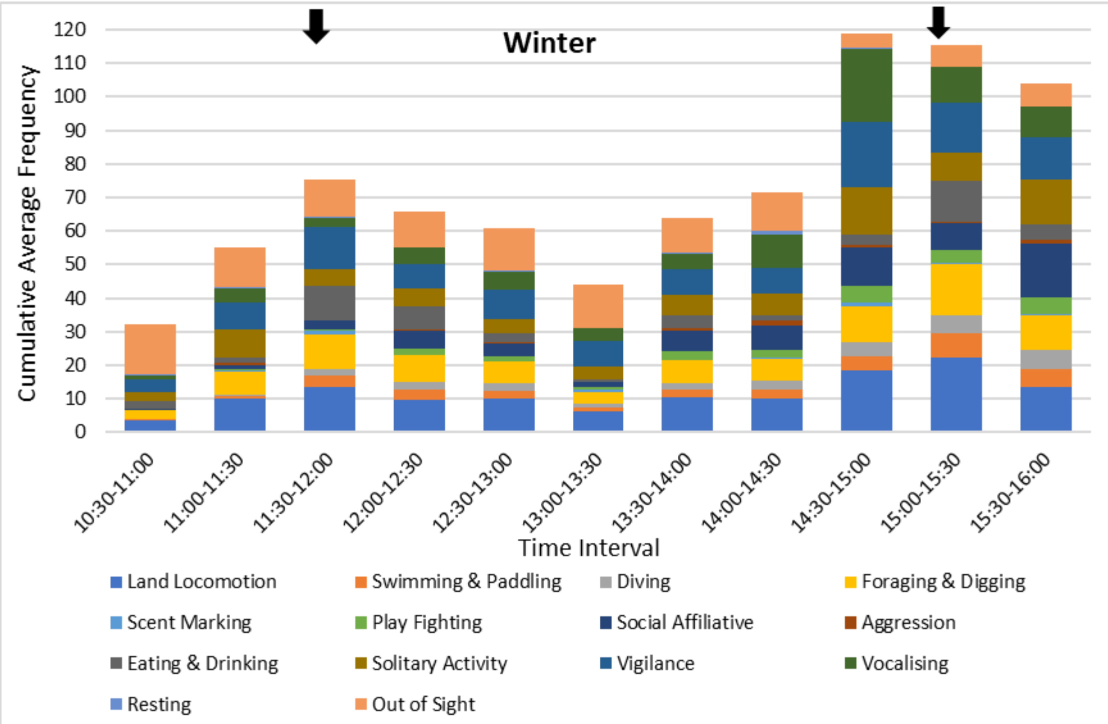


Figure 10: Day time activity pattern for the adult otters in winter. Arrows represent feeding times. Values represent average frequencies of recording for each behavioural category and each time of day (n=5). Outcomes of Kruskal-Wallis test for influence of time of day: Eating & Drinking**, Out of Sight*, Solitary Activity*, Swimming*. Asterisks denote statistical significance at $P \leq 0.05$*, $P < 0.01$**.

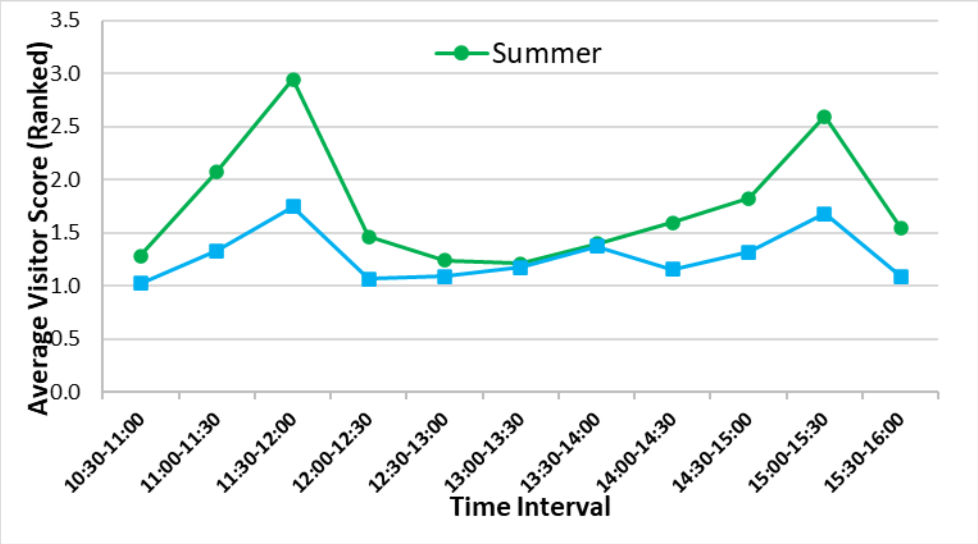


Figure 11: Day time variation in visitor numbers in summer and winter 2016 (feeding and public talks at 11:30 and 15:00). Values represent average ranked scores (n=75) (1 = only 1-2 people present; 2 = 3-4 people; 3 = 5-10 people; 4 = 11-20 people; 5 = more than 20 people).

Cub Development

All four cubs born in March 2016 at WWT Washington progressed very well. By 4 weeks-old, they had roughly doubled their weight, compared to the first weigh-in at nearly 2 weeks-old (Figure 12, Table 3) and were seen outside from 2 months-old. By 3.5 months old (June 2016), although they had not been weaned yet, they were spending more time outside around feeding times, eating solid food and displaying a much greater variety of behaviours (Figures 13-14, Table 3). The relative frequency of swimming & paddling and diving increased from 3.5 months-old to 6 months-old, with the relative frequency of diving at 6 months-old being significantly higher than at all other stages (6.9% > [0.3-2.7%]; Z=28.588; p<0.001) (Figure 14). The relative frequency of cubs being 'out of sight' was at its lowest in August 2016, at 6 months-old.

a) b)

c) d)

Figure 12: Early photographic records of the otter cubs born in March 2016 (a-c) (Photos Copyright a-c: WWT) and of early swimming lessons (d) (Photo Copyright: Jans Bartholomew)

Table 3: Summary of otter cubs development at WWT Washington in 2016 (based on direct observations and information from WWT Washington).

Age	Notes
12 days (week 2)	First weigh in: 115-160g
26 days	Second weigh in: 295-325g
59 days 2 months-old	Cubs already taking short trips outside after feeding, especially in good weather.
66 days 2 months-old	Cubs coming out on their own at feeding time; eating prawns; squeaking; climbing on t each other to get back into the den.
103 -110 days 3.5 months-old	Eating larger pieces of solid food, foraging close to parent or older sibling; moving aro as a group with parent/ older sibling at other times; swimming with head out, climbing the lower tree stumps; seen suckling outside.
118 days 4 months-old	Playing, juggling pebble, rolling on grass or bark, vigilance standing, still moving arou the enclosure mostly as a family group. Ash seen climbing on the tallest tree stump. *(D grouped with those for 3.5 months-old in Figure 14)*
139 days 4.5 months-old	More independent, occasionally seen foraging or playing further away from parents, swimming more in the deeper pool and occasionally with head under the water (record diving).
181 days 6 months-old	Even more independent, not following adults as much, more solitary activities (eating, juggling), lots of play fighting (water), swimming and diving in the deep pool.
8-9.5 months-old	Very independent, doing things both on their own and as a family group; lots of foragin diving, climbing, digging, running, exploring, play fighting and playing with pebbles t straw, eggs, shells; adults still very vigilant and responsive to strange noises.

a) b) c)

Figure 13: Behaviours displayed by otter cubs at WWT Washington in June 2016: a) Suckling and resting close to adult female; b) Vigilance standing; c) Juggling round object (avocado seed). (*Photos Copyright a-c: Mirela Cuculescu-Santana*)

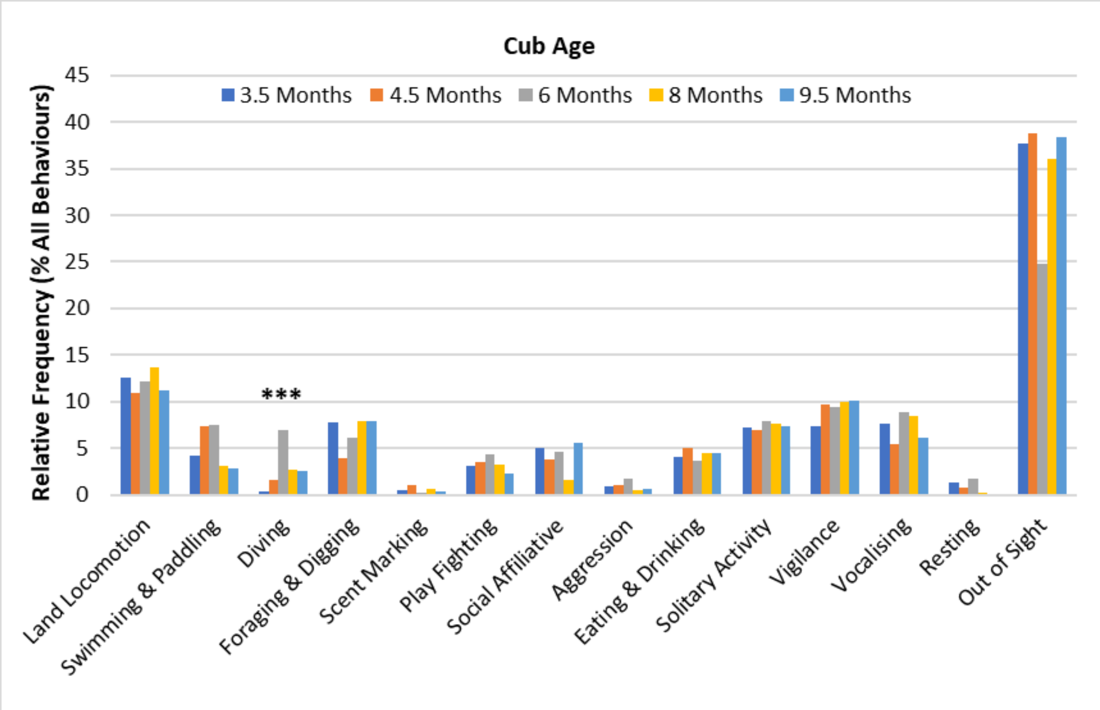


Figure 14: The influence of cub age on cub behavioural budgets. Values represent average percentages out of all the behaviours recorded per observation period at each developmental stage (n=33 for ages 3.5 and 9.5 months; n=11 for ages 4.5 and 6.0 months; n=22 for age 8.0 months). Asterisks denote statistical significance at $P<0.001$*** (Kruskal-Wallis test).

Mating Behaviour

Mating behaviour of the adult pair was observed several times on the days of data collection, in both seasons (Table 4), around midday and in early afternoon, only in the water in summer and only out of water in winter. The duration varied in both seasons, from 1 minute (nudging, clasping, gentle biting) to 14-16 minutes (holding on to each other in the water and rolling around and splashing together, in summer, or mounting on the grass, holding on to one another, rolling together, moving against each other, nudging and gentle biting in winter).

The video recording of one of the longer encounters that took place on the grass in the front area of the enclosure in November 2016 is available as supplementary material (ASCO Mating WWT Washington November 2016). Mating started with the male holding on to the female and moving rapidly against her in one of the positions shown in Figure 15 (a-c) in what appeared to be genital stimulation without copulation. This was followed by the female mounting the male (Figure 15d) and moving slower against him, when actual copulation took place.

Table 4: Mating behaviour observed at WWT Washington in summer and winter 2016. Time and frequency of occurrence and approximate duration of bouts of sexual behaviour.

Time Interval	10:30-12:00	12:00-14:00	14:00-16:00
Summer			
Nr of Mating Events Observed	0	4	13
Range of Duration	-	1-10 min	1-14 min
Total Time (approx.)	-	28 min	66 min
Winter			
Nr of Mating Events Observed	0	7	7
Range of Duration	-	1-16 min	1-16 min
Total Time (approx.)	-	42 min	52 min

DISCUSSION
Seasonal and Enrichment Influence

The Asian small-clawed otters (ASCO) at the WWT Washington were active outdoors in both summer and winter 2016, with peaks of activity and more diverse behaviours displayed around feeding times. The feeding strategy used included four feeds a day, with food scattering and hiding around the enclosure. The outdoor area had a variety of structural enrichments (natural substrates, vegetation, water features and climbing structures) in very good compliance with the guidelines for the species (AZA, 2009). The otters displayed several naturalistic behaviours, such as foraging on land and in water, digging, paddling, swimming, diving and social play, similar to those described for otters in the wild (Kruuk, 2006, Hussain et al., 2011) and associated with high welfare in captive otters (AZA, 2009).

As expected, there were significant seasonal differences in the behaviour of both adults and cubs, correlated with significant differences in enclosure use. The adult pair and the four cubs born in March 2016 swam (adults 7.1% summer > 2.9% winter; cubs 5.5% summer > 2.9% winter) and interacted with the water features significantly more frequently during the summer (adults 24% summer > 14% winter; cubs 19% summer > 14% winter), when the water was warmer (15-25 °C; average 19 °C; n=5 days). The adults also dived significantly more frequently in summer (5% > 2.6% winter), while for the cubs the relative frequency of diving was significantly higher in winter (2.6% > 1.9% summer), when they were overall more confident swimmers and divers.

a) b) c) d)

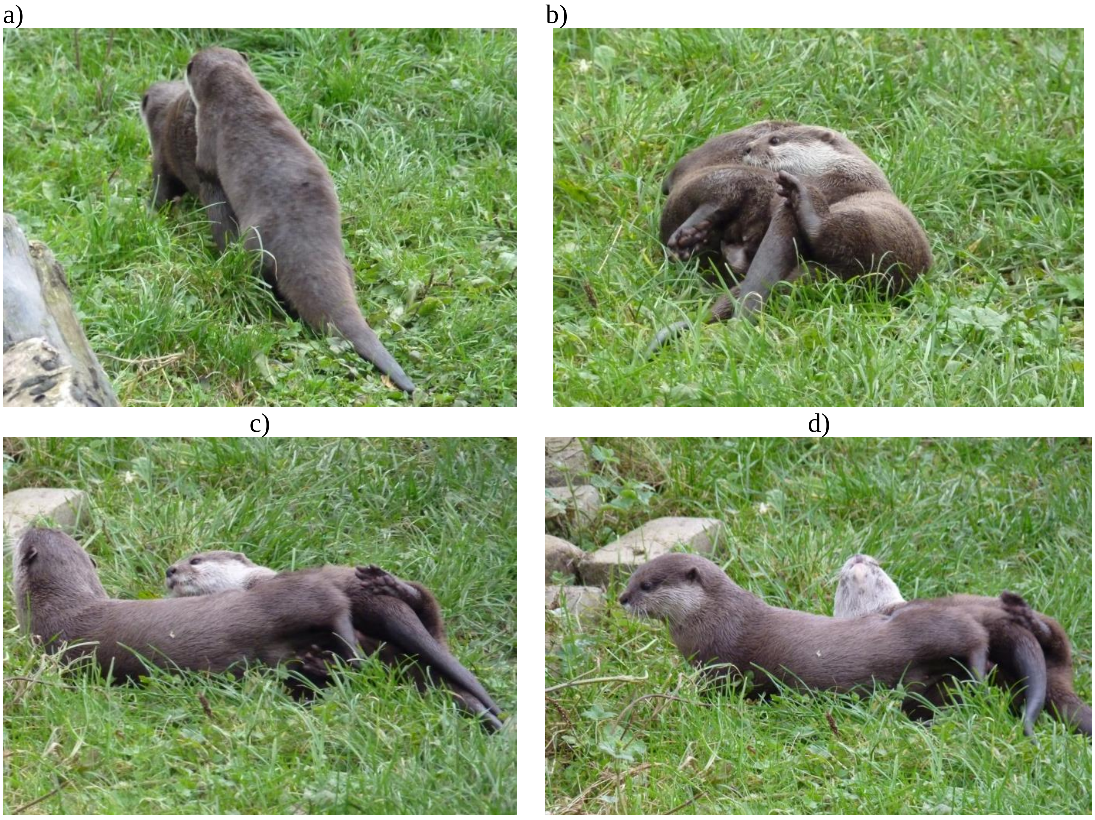


Figure 15: Adult otters mating out of water in November 2016: a) male mounting the female; b)-c) male rubbing against female, with no copulation; d) female mounting the male and copulation with slower movements. (*Photos Copyright a-d: Mirela Cuculescu-Santana*; Video available as additional material at [ASCO Mating WWT Washington November 2016] ; *Video Copyright: Mirela Cuculescu-Santana)*

In summer the pools were used for paddling, swimming, diving, foraging, play-fighting and sexual behaviour (the adults). Adults and cubs were often seen diving or searching the surrounding vegetation for scattered or hidden food, then eating it while still in shallow water. In winter, when the water was much colder (range 3.5-8 °C; average 6.5 °C; n=5 days), the otters still used the pools for swimming, diving, foraging and play-fighting, but less frequently than in the summer. Several occurrences of 4 minutes or longer spent continuously in the water were recorded for both the focal adult (the male) and cub (the white-furred female cub) in summer, while none were recorded in winter, when the majority of the swimming bouts lasted 1 minute or less. The adults used the den significantly less frequently in summer compared to winter and both adults and cubs were seen resting outside significantly more frequently in summer than in winter.

Similar findings were reported for ASCO living in a non-climatised indoor enclosure, who spent 33.4% of their time swimming in the summer, in water at 18-19 °C, compared to only 14.1% in winter, in water at 11-12 °C, when they spent more time resting and displayed more frequent begging and aggression (Cuculescu-Santana et al., 2017). Continuous swimming for more than 1 minute was never recorded in winter in the indoor pool and the longest swimming bout recorded in summer lasted 3 minutes (Cuculescu-Santana et al., 2017), when even in the summer the water was rarely warmer than 18.3 °C, the lowest recommended water temperatures for this species (AZA, 2009). As tropical warm-adapted mammals, ASCO have higher metabolic costs for thermoregulation than other Mustelids, especially in water below 16°C, which is estimated to be close to the lower extreme of their thermoneutral zone (Borgwardt and Culik, 1999). The metabolic rate of ASCO during rest on land at 16°C almost doubled when resting in cold water at 12 °C and increased further during swimming and foraging (Borgwardt and Culik, 1999). Movement in cold water increases the heat loss through forced convection through the skin (Hind and Gurney, 1997), which in ASCO is not fully compensated by the heat generated in muscles (Humphries and Careau, 2011). ASCO and another tropical species, the giant otter *Pteronura brasiliensis*, have shorter primary hairs in their coat than other otter species and thermal imaging showed they lost heat through the entire body surface, including the tail, while the better cold-adapted Eurasian river otter (EARO) *Lutra lutra* dissipated heat mainly through their feet (Kuhn, 2009; Kuhn and Meyer, 2009). EARO increase their body temperature through more activity on land before a foraging dive in cold water, which allows them to remain in the water until their body temperature decreases again to their average resting value (Kruuk et al., 1994a; Kruuk et al., 1997).

The structural enrichments added in autumn to some of the back and lower end areas of the otter enclosure at WWT Washington increased significantly the frequency of use of these areas in winter, probably due to initial novelty factor as well as longer-term increase in the spatial complexity of the ground areas and very likely contributed to maintaining good levels of diurnal activity and high display value in the cold season. The cubs played for up to 20-30 minutes at a time inside and around the newly added nest box and small holt and on the logs at the back of the enclosure, after the vegetation around them was trimmed. Frequent changes in enclosure “furniture” and management of the natural vegetation are among the recommended practices to stimulate active exploration (AZA, 2009) and enhance the quality of the space for captive otters (Foster-Turley et al., 1990). The front area of the enclosure was used significantly less frequently in winter compared to summer, when it was used for access to the pools, drying after swims and for resting outside and affiliative social interaction.

The levels of aggression were low in both seasons (0.6-1%). Vigilance (8-12%) and vocalisations (7-8%) were among the most frequently recorded active behaviours in both seasons, suggesting that the adults were very alert due to the presence of the cubs and used contact calls to co-ordinate the activities of the family group, such as swimming lessons or foraging. Soft calls (chirps) could be heard every time the family group was on the move, and often during periods of low activity, too, similar to the contact vocalisations described by Lemasson et al. (2014). The roles within the family group at WWT Washington were also similar to those described by Lemasson et al. (2014) for a family of ASCO at a zoo in France, with the adult male leading the group and the adult female carefully watching the surroundings during movement to the pools and back to their resting area. The male and the 1-year old cub were play-fighting more with the cubs and the female was usually surrounded by cubs during social rest. The male and the female were often seen resting together outdoors, in close body contact. As expected, the cubs displayed more play-fighting than the adults and less allogrooming and body contact. Play-fighting is a complex behaviour that is essential for the development of social as well as cognitive and emotional competencies in juvenile mammals (Pellis and Pellis, 2013; Palagi et al, 2016), and was another indicator of high welfare as it was often seen in wild otters (Kruuk, 2006; Reed-Smith et al., 2014).

The activity patterns observed in both summer and winter were consistent with the existence of a rhythm of activity entrained by fixed feeding times (Mistlberger, 2011; Carneiro and Araujo, 2012) and with those reported for ASCO at other establishments (Hawke et al., 2000; Ross, 2002; Cuculescu-Santana et al., 2017). The higher levels of activity around feeds were related to appetitive behaviours indicative of good welfare (Watters, 2014) and were paralleled by peaks in visitor numbers. Several visitors also stayed to watch the otters during the quieter periods of social play, solitary play or rest between feeds. The frequency of repetitive behaviours associated with more stressful feeding anticipation, such as vigilance standing and loud short calls (Scheifele et al., 2015) was higher in winter, especially before the 3:00pm feed, suggesting greater hunger due to the increased energetic costs of thermoregulation in the cold season (Gothard, 2007; Cuculescu-Santana et al., 2017). At other times, vigilance standing was usually displayed in response to unfamiliar noises or events (eg a maintenance vehicle stopping next to their enclosure), rather than as repetitive “begging” to keepers or visitors. Peaks in activity associated with food acquisition have been described for wild otters (Hussain, 2013). Their timing appeared to be influenced by seasonal temperatures (Reed-Smith et al., 2014) and by the patterns of nearby human activity (Foster-Turley, 1992; Castro and Dolorosa, 2006).

Parental Care and Reproductive Behaviour

The adult pair displayed more social affiliative behaviours in the summer, associated with more parental care (e.g. suckling, food sharing, cub grooming, play) and with periods of lower levels of activity outside, when social grooming and body rubbing between the adults were recorded, while the cubs were still inside the den. The pair displayed sexual behaviour in both seasons, for up to 14-16 minutes, usually in the early afternoon, at quieter times. Giant otters at a zoo in Colombia also displayed sexual behaviour at times with fewer visitors around (Corredor-Londono and Tigreros-Munoz, 2006). Courtship behaviours in ASCO include genital stimulation and the female mounting the male (Kuenzer and Lombardi, 1998) and the out-of-water sexual interaction observed at WWT Washington appeared to involve first a stage of stimulation during which the male was rubbing against the female, without copulation, in ventral-to-dorsal or ventral-to-ventral position, followed by copulation during which the female mounted the male in a ventral-to-ventral position and moved slower against him.

ASCO are reproductively active all year round (Bateman et al., 2009) and the fact that mating at WWT Washington was observed only in the water in summer and only out of water in winter, when the water temperature was below 10 °C on all days of data collection, suggested that ASCO adjusted their sexual behaviour to compensate for the increased cost of thermoregulation in cold water (Borgwardt and Culik, 1999). ASCO is among the otter species whose behaviour is least studied in the wild and most of the information about mating behaviour is based on observations in zoos outside its natural distribution range (Hussain et al., 2011). Copulation can last up to 45 minutes and can occur several times a day, both on land and in water, with the dorsal-ventral position being the most common (Reed-Smith and Polechla, 2002). In giant otters and sea otters the male bites the female during mating and copulation may last up to 20-30 minutes (Kruuk, 2006). Only gentle biting occurred at WWT Washington during mating out of water, but the instances of sexual behaviour that took place in the water during the summer involved more energetic rolling around, tumbling, lots of splashing, vocalisations and possibly more aggressive biting, too. EARO seen mating in the water in spring in Shetland also had a quieter period of holding on to each other after rolling, tumbling and splashing around (Kruuk, 2006).

ASCO produce litters of 1-7 cubs, with an approximate sex ratio of 1:1 (Hussain et al, 2011). The pair at WWT Washington produced three successful litters: one female cub (2015), the four included in this study (3:1; 2016) and four more (2:2) in 2017. Both parents were involved in caring for the cubs, with help from the 1-year old sibling, as reported for other captive ASCO pairs (Sivasothi, 1998; Nair and Agoramoorthy, 2002; Hussain et al, 2011).

Cub Development

The cubs at WWT Washington were already paddling and swimming with the head out of water around 3.5-4 months-old (15-17 weeks), always accompanied by the adults, with frequent contact calls, but were only rarely seen with the head under water (diving). Their development was consistent with other reports for captive ASCO up to weaning age (AZA, 2009; Hussain et al., 2011). At 16 weeks-old they were not completely weaned, as suckling was observed during periods of rest outside. ASCO cubs looked after by their parents usually begin to come out of the birthing den around 2 months-old, eat first solids and begin swimming lessons with parents around 2-3 months-old and are weaned around 3.5-months old (Hussain et al., 2011). Leslie (1971) described 3 months-old ASCO cubs playing outside with their parents, exploring all areas of the enclosure apart from the pool (the parents disliked the water) and starting to enjoy the water after being pushed in by keepers, even taking turns at repeatedly sliding down the embankment into the water. Two hand-reared ASCO cubs at Miami Metro Zoo showed interest in solid food and were able to catch small fish at 8 weeks-old, started playing in shallow water around 2 months-old, were swimming in a deep pool by around 3.5 months-old and were weaned around 4.5 months-old (Webb, 2011).

By 4-4.5 months-old the cubs at WWT Washington were displaying several otter-specific behaviours. They climbed confidently on the structures in the enclosure, were rolling on the grass or bark to dry their fur after swimming and displayed vigilance standing, which is a sign of alertness to unfamiliar noises and possible danger in wild otters (Kruuk, 2006). They also juggled pebbles, demonstrating forepaw dexterity (Larivière, 2003) which is particularly important for ASCO as hand-oriented predators (Timm-Davis et al., 2015). Wild ASCO capture most of their food by searching with their forepaws under rocks and in crevices on the bottom of water bodies, which in captivity is reflected in well-developed forms of object manipulation and play (Pellis, 1984) and ability to open different types of containers and solve puzzles to extract food (Ladds et al., 2017; Allison et al., 2020).

The relative frequency of swimming and paddling increased from 3.5 to 4.5 months-old, while the relative frequency of diving was still low at 4.5 months-old and increased significantly only around 6 months-old, as the cubs became more confident swimmers. The lowest frequency of being inside the den was recorded at 6 months-old (end of August 2016), when the cubs spent a lot of time outside, moving around the enclosure, swimming and play-fighting, and demonstrating an increased level of independence, especially when foraging around feeding times. In the wild ASCO live in social groups but forage individually (Kruuk et al., 1994b). By 8-9.5 months-old the cubs were even more independent and their behavioural budget was similar to that of the adults, apart from sexual behaviour. They were already confident swimmers and divers and were often seen at some distance from the adults, retrieving successfully pieces of food from the pools, suggesting competence with both diving and aquatic foraging skills by this age.

The ability to acquire enough food around 14 weeks-old, when weaning usually occurs appeared critical for the survival of cubs (Prima, 1992) and many captive cub deaths occurred around this age. There is very little information in the peer-reviewed literature about ASCO cub development post-weaning and it is not known how they develop in the wild (Kruuk, 2006). There are reports of sightings of family groups (Foster-Turley et al., 1990; Sivasothi and Nor, 1994; Castro and Dolorosa, 2006) and of adults carrying cubs with their forepaws or under their chins (Sivasothi and Nor, 1994). In species with complex group structure, such as giant otters and ASCO, cubs remain dependent on mothers or on family group for long periods of time until they develop adequate food acquisition skills (Kruuk, 2006). For captive ASCO it is recommended that cubs remain with their parents up to around one year-old, to have the chance to learn not only survival skills, but also how to raise cubs (Heap et al., 2008). Yearling ASCO cubs at Chester Zoo spent more time in solitary behaviours such as digging and playing with objects and less time engaged in social interaction than the adults (Owen, 2004).

Behavioural ontogeny in other species of otter follows similar patterns. In sea otters the period of cubs dependence on the mother varies with geographical area, from 6 to 12 months-old, longer where the predominant food is fish (Kruuk, 2006). The period of dependence is usually longer in other species for which the main food is fish, such as giant otters (GO) and North American (NARO) and Eurasian river otters (EARO). GO have a complex social organisation, similar to that of ASCO, maintained by complex vocalisations and frequent mutual grooming (Mumm and Knornschild, 2014; Groenendijk, 2019). GO cubs travel and catch fish with their family group from 3-4 months-old, often play in the water while the adults are resting out of water, and are protected and fed cooperatively by all members of the group (Evangelista and Rosas, 2011). They are completely weaned by 5-6 months and stay with the family group up to 2 years-old (Kruuk, 2006). Eurasian otter cubs (EARO) begin weaning around 2 months-old and start fishing as a family group with their mother from 8-10 weeks-old, with frequent contact calls (Kruuk, 2006). Fishing lessons and prey capture play were seen in wild EARO and although by 4-5 months-old the cubs were able to catch fish, they remained with the family up to 10-11 months-old or even longer, presumably because underwater hunting skills take longer to develop and require more practice than terrestrial hunting (Kruuk, 2006). Captive EARO cubs were displaying uncoordinated surface swimming and diving from around 3 months-old, learning swimming and hunting techniques from their mother (Polotti et al., 1995). Similar to the ASCO cubs in our study, by 8 months-old they were spending less time with their mother, hunting and sprainting independently, and by 9 months-old they had developed coordinated surface swimming (Polotti et al., 1995). NARO cubs begin swimming around 2.5 months-old, take first deep dives and begin to fish at 3 months, become efficient and dextrous swimmers by 6 months-old, but can take up to 10 months-old to become efficient foragers and stay with their families up to 8-12 months-old (Shannon, 1998).

LIMITATIONS OF THE STUDY

We presented a case study based on observations carried out over 7 months at a single establishment, outlining the main changes in the behaviour and enclosure use of a family of Asian small-clawed otters under the combined influence of seasonality, cub age progression and on-going enrichment strategies, making it difficult to propose direct cause and effect relationships, as well as to replicate such a combination of conditions elsewhere.

CONCLUSIONS

1. Seasonal temperatures had a significant influence on the behaviour and outdoor enclosure use of *Aonyx cinereus* at WWT Washington, who rested outside and used the pools significantly more frequently in summer, when the water temperature was closer to or within the 18.3-29.4 °C range recommended for the species, compared to winter, when the water temperatures were below 10 °C.
2. The behavioural budgets of ASCO cubs from 3.5 to 9.5 months-old showed that the cubs were displaying vigilance, co-ordinated swimming and forepaw dexterity at 4.5 months-old and confident diving and underwater swimming at 6 months-old. By 9.5 months-old they were foraging independently, engaged more in social grooming, but still played more frequently than the adults.
3. The feeding and structural enrichment strategies used at WWT Washington maintained good levels of activity outdoors and high display value all year round and very likely contributed to the successful reproduction of the ASCO pair, who produced a total of 9 cubs, some of which have already reproduced successfully themselves at the establishments where they were moved, emphasizing that captive ASCO need various forms of enrichment to stimulate behaviours similar to those in the wild and maintain good welfare all year round.

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RÉSUMÉ

UTILISATION DE L'ENCLOS EXTERIEUR ET COMPORTEMENT CHEZ L'ADULTE ET LE LOUTRON DE LA LOUTRE CENDRÉE *Aonyx cinereus* EN ÉTÉ ET EN HIVER

Le comportement et l'utilisation de l'enclos extérieur d'une famille de loutres *Aonyx cinereus* ont été étudiés en été et en hiver au Centre Wildfowl and Wetland Trust Washington, au Royaume-Uni. En été, la nage, le pataugeage (adultes et jeunes) et la plongée (adultes) ont été observés de manière significative plus fréquemment qu'en hiver, ce qui est en corrélation avec des fréquences d'utilisation du milieu aquatique nettement plus élevées. Pour les loutrons, la fréquence relative de plongée était significativement plus faible qu'en hiver, car les jeunes apprenaient encore à nager et à se nourrir sous l'eau. Les niveaux d'activité et la diversité des comportements étaient plus élevés aux heures de repas durant les deux saisons. Les loutrons nageaient déjà dans des eaux peu profondes à l'âge de 3,5 mois et dans des eaux plus profondes à 4,5 mois, principalement en groupe familial. À l'âge de 3,5 à 6 mois, ils étaient beaucoup plus souvent dans la catiche, donc moins visibles que les adultes et montraient davantage de jeux combatifs. À l'âge de 8 à 9,5 mois, ils se déplaçaient de manière autonome, en quête de nourriture ou en jouant et leur attitude comportementale était similaire à celle des adultes. La jonglerie avec un objet et la station debout avec vigilance sont apparues à partir d'environ 4 mois, lors du sevrage. L'apport de structures supplémentaires (souches, terrier, nichoir) au début de l'automne a augmenté la fréquence d'utilisation d'espaces au sol en hiver, lorsque la température de l'eau était inférieure à 10 °C. Les stratégies d'alimentation et l'augmentation des structures utilisées ont été efficaces pour maintenir les loutres actives à l'extérieur et garder leur attractivité élevée durant la saison froide (températures de l'air en été de 15 à 27 °C > en hiver de 3,5 à 10 °C), soulignant l'importance de l'apport des structures pour un bien-être animal satisfaisant.

RESUMEN

USO DE UN RECINTO EXTERIOR, Y COMPORTAMIENTO DE UN ADULTO Y UNA CRÍA DE NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA *Aonyx ciniereus* EN VERANO E INVIERNO

Investigamos el comportamiento y el uso de un recinto exterior, por una familia de *Aonyx cinereus*, en verano e invierno en el Wildfowl and Wetland Trust Washington, Reino Unido. En verano, la natación y propulsión acuática (adultos y crías) y el buceo (adultos) fueron registrados significativamente con más frecuencia que en invierno, correlacionado con frecuencias significativamente más altas de uso de los dispositivos acuáticos. Para las crías, la frecuencia relativa de buceo fue significativamente más baja comparada con el invierno, ya que las crías estaban aún aprendiendo a nadar y alimentarse bajo el agua. Los niveles de actividad y la diversidad de comportamientos fueron más altos alrededor de los momentos de alimentación, en ambas estaciones. Las crías ya estaban nadando en aguas poco profundas a los 3.5 meses de edad, y en aguas más profundas a los 4.5 meses de edad, mayormente como grupo familiar. A los 3.5-6 meses de edad estaban ocultas en la madriguera significativamente con más frecuencia que los adultos, y desplegaban más juego-pelea. Para los 8-9.5 meses de edad se movían independientemente, alimentándose o jugando, y su presupuesto de comportamientos era similar al de los adultos. El malabarismo con objetos, y pararse en posición vigilante, se desplegaron a partir de unos 4 meses de edad, cuando también ocurrió el destete. La introducción de enriquecimiento estructural adicional (troncos, cuevas, caja-nido) a principios de otoño incrementó la frecuencia de uso de las áreas terrestres en invierno, cuando las temperaturas del agua estaban por debajo de los 10° C. Las estrategias de alimentación y de enriquecimiento estructural utilizadas fueron efectivas para mantener a las nutrias activas en esta situación de aire libre, y para mantener su alto valor de exhibición en la estación fría (las temperaturas diurnas del aire en verano 15-27 °C > invierno 3.5-10° C), enfatizando la importancia del enriquecimiento para un adecuado bienestar.

R E P O R T

NEW SCENT MARKING BEHAVIOR OF NEOTROPICAL OTTER (*Lontra longicaudis*) IN THE EASTERN BRAZILIAN AMAZON

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Abstract: Scent marking behavior in mammals is related with both inter and intra-specific communication. Several otter species are known to communicate via scent marking, but a couple scent marking has not been documented in the Neotropical Otter (*Lontra longicaudis*). We obtained field observations of scent marking behavior in Neotropical Otters over two years using camera traps along waterways in the eastern Brazilian Amazon. Our results reveal the use of sandy substrates on islands and river margins for intra-specific communication between otters. Most records (62.5%) were from solitary adults. We document multiple independent records of adult otters digging to scent mark with urine and couple behavior of males urinating on top of female's fresh urine in newly dug shallow craters. We also demonstrate behavioral plasticity of this species evidenced by camera traps recording terrestrial activity during both day and night. Our results contribute to improve the knowledge of the behavior of this otter species in the wild and can potentially be applied to improve *ex-situ* welfare of captive otters.

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Keywords: Digging, Couple behavior, Intra-species behavior, Mammal, Carnivore, Mustelidae

INTRODUCTION

Most mammals are known to scent-mark with urine, feces and sometimes with glandular secretions (Ralls, 1971; Johnson, 1973; Thiessen and Rice, 1976). Within this context, carnivores deploy their excreta for diverse reasons, with the use of scent marking showing substantial intra-specific variation (MacDonald, 1980). Scent marking functions in carnivores are known to be related to affirm dominance (Gese and Ruff, 1997; Allen et al., 2017), defend food resources (Piñeiro and Barja, 2015), maintain territories (Smith et al., 1989; Roper et al., 1993), selecting and advertising for mates (Allen et al., 2015; 2016), among other inter- and intraspecific communications.

Like most mustelids otters use scent marking to communicate (Johnson, 1973; Kruuk, 1992; Ben-David et al., 2005; Kean et al., 2011). Scent marking in otters can occur in different forms, for example, mucus may be added to the spraint prior to deposition or mucus may occur in isolation without fecal material, which suggests a more complex cause and function that simply as a feces-finding substance (Kruuk, 2006; 2014). Several hypotheses for the functions of scent marking by Eurasian Otters (*Lutra lutra*) have already been tested, with results showing that spraints at latrines function to communicate social status of males (Rostain et al., 2004). Scent marking helps maintain the social system in cooperative species and has been shown to be important for group dynamics of territorial Giant Otters (*Pteronura brasiliensis*) (Carter and Rosas, 1997; Leuchtenberger and Mourão, 2009). The more solitary Neotropical Otters (*Lontra longicaudis*) also use scent marking for communication between individuals, with information transmitted by the deposition of spraint, feces and mucus in conspicuous locations such as rocks, fallen tree trunks, and sand banks along rivers (Dunstone and Strachan, 1988; Rheingantz et al., 2016; 2017; Roberts et al., 2016). This communication between Neotropical Otters has been linked with the role in determining space use and sexual behavior (Larivière, 1999).

Although the Neotropical Otter (*Lontra longicaudis*) is classified as Near Threatened by the IUCN and has a wide distribution in the Neotropics (Rheingantz and Trinca, 2015), there are several gaps in our knowledge of this species behavior (de Almeida and Ramos Pereira, 2017; Rheingantz et al., 2017). Indeed, due to the difficulty in obtain direct field observation, information on the ecology and behavior of this elusive species is scarce, with most information based on indirect records (feces, scratches, and footprints) collected in the field (Rheingantz et al., 2017). Studies focusing on communication and general behavior of *L. longicaudis* corresponded to only 2 and 4%, respectively of all research evaluated with this species in a recent review (de Almeida and Ramos Pereira, 2017). Knowledge on animal behavior enables to develop successful solutions to *ex-* and *in-situ* conservation, as well as to propose solutions to wildlife management issues (Campbell-Palmer and Rosell, 2011).

In this study, we document field observations on previously unreported scent marking behavior of *L. longicaudis* obtained by camera traps. The intra-specific behavior observed in our study can potentially inform *ex-situ* welfare. Based on our findings we also suggest that habitat use and occupancy data based solely on indirect fieldwork may be biased and should be analyzed carefully for this species.

MATERIALS AND METHODS

Study area

The study was conducted along 39 km of the Falsino River, in the State of Amapá, Brazil (N 0.77327, W 51.58064; Figure 1). This river segment runs between two sustainable-use protected areas, the Amapá National Forest and the Amapá State Forest (hereafter “FLONA” and “FLOTA”, respectively). This particular stretch of river is 61 km from the nearest town and suffers relatively little anthropogenic influence (Norris and Michalski, 2013; de Oliveira et al., 2015; Norris et al., 2018), with only 3-6 houses in the river segment during our study period.

The regional climate is classified by Köppen-Geiger as “Am” (Equatorial monsoon) (Kottek et al., 2006), with the driest months from September to November (total monthly rainfall < 150 mm) and the wettest months from February to April (total monthly rainfall > 300 mm) (Paredes et al., 2017).

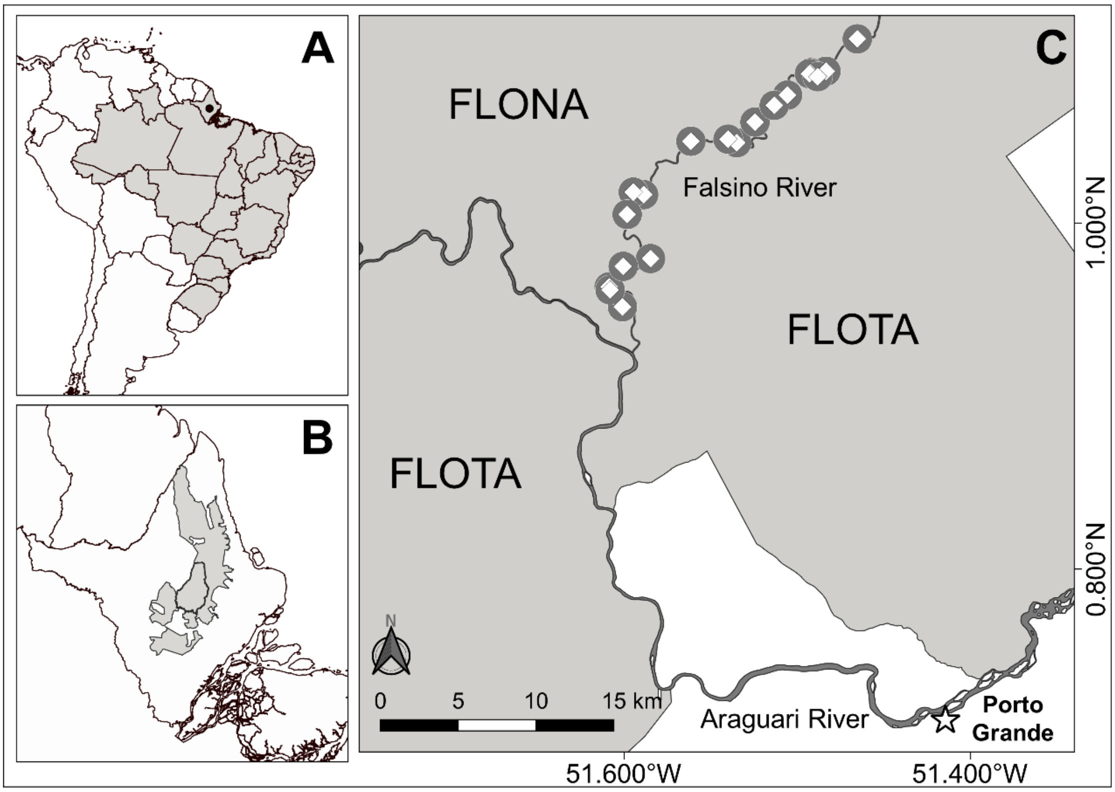

Figure 1: Location of the study region between the Amapá National Forest (FLONA) and the Amapá State Forest (FLOTA), Amapá State, eastern Brazilian Amazon. (A) Amapá State in Brazil; (B) FLONA and FLOTA (polygons) in Amapá State; (C) Linear dark grey representing Araguari and Falsino rivers with circles and diamonds, representing sampling site locations where camera traps were installed in 2018 and 2019, respectively. The star shows Porto Grande city, the nearest town in our study region.

Study periods and sampling methods

We obtained data on Neotropical river otter behavior using camera traps equipped with infrared triggers (Bushnell Trophy Cam, 8 MP, Overland Park, KS, USA). Camera traps were installed on islands and river margins during the low river level season (de Oliveira et al., 2015), when islands and sand banks along the river are exposed. Sites were selected based on the following criteria: areas of > 5 m^2 of exposed sand and/or fine gravel that were sufficiently raised above the river level not to be waterlogged at a depth of 15 cm (Quintana et al., 2019; Michalski et al., 2020). Sites were not selected to maximize otter encounters or on previous evidence of otter activity. We sampled sites in two consecutive years, with cameras installed in 19 sites from August to December 2018, and in 19 sites from September to December 2019. We maximized the spatial independence between sites by establishing an average (± SD, range) distance along the river of 15.5 km (± 10.4 km, min.-max. =0.06–39.0 km, n=342 comparisons) in 2018, and an average (± SD, range) distance along the river of 15.5 km (± 10.4 km, min.-max. = 0.05–39.0 km, n=342 comparisons) in 2019. Cameras (min.–max. = 1–2 per site) were unbaited, installed at 30-40 cm above the ground and faced the largest open area of the island or margin bank. Cameras functioned continuously (24 hours a day) and were configured in hybrid mode (taking three photos followed by a 40 seconds video film post-activation), with intervals of 15 seconds between videos, and date-time stamp enabled. Here we consider the three photos and video as a single event.

Data analyses

We used the R language with environment for statistical computing (R Development Core Team, 2019) to generate figures and analysis presented in this study. To determine the distances between each site surveyed along the river as well as total river length sampled we used functions available in the R (R Development Core Team, 2019) package "riverdist" (Tyers, 2017). When analyzing data for activity pattern behavior, we only used independent detections, with photos/videos only considered with over 30 minutes interval when the same species was recorded during the same day on the same camera (Michalski et al., 2015; Paredes et al., 2017) or when the individuals could be clearly distinguished using scars, or other visibly unique marks. Information on otter behavior and gender were obtained using frame-to-frame video observations. Gender was confirmed by two researchers (FM and MLR) with over 15 years of experience working with mammals and otters using a double-blinded method.

RESULTS

Following a sampling effort of 2822 trap-days (mean ± SD = 65.6±14.2, range = 38 – 106 per camera trap), we obtained eight independent detections of *L. longicaudis* (Table 1), with an overall capture rate of 0.3 detections per 100 trap-day.

Table 1: Study sites, sampling effort and number of detections of *Lontra longicaudis* in the eastern Brazilian Amazon.

Year	Number of sites (total number of cameras)	Total camera-trap days (Mean ±SD)	Number of cameras with otter detections	Total independent otter detections (single/pair)
2018	19 (22)	1471 (67±17.1)	6	6 (4/2)
2019	19 (21)	1351 (64±10.3)	2	2 (1/1)

Most of the *L. longicaudis* detections (75%) were obtained during the day, with only two records detected at night (Figure 2). Half of the records of otters were obtained early in the morning, between 06:00AM and 07:00AM (Figure 2). Solitary adult otters were detected in 62.5% (n=5) of all records and the remaining three events showed two adult otters simultaneously. From the total of eight detections we could only identify gender on four occasions, when the genitalia could be clearly distinguished; being two solitary adult males, and two occasions of male-female couples recorded together.

The majority of otter behavior detected by camera traps was characterized as walking along the sand banks (n=5, 62.5%), but on three occasions (37.5%) we could clearly distinguish behaviors that could be characterized as digging and scent marking, and in one occasion (12.5%) we identified a rubbing behavior.

Digging

Digging is defined as using front paws to remove the substrate forming a shallow crater. In three independent events (19 October 2018 at 06:52AM, 01 December 2018 at 06:22AM, and 05 November 2019 at 07:04AM), adult female and male otters dug the sandy substrate along the river margin. After digging, the otters subsequently returned to the water, with all craters always remaining uncovered/open. During one of these events (01 December 2018), the adult female otter excavated three different craters in less than 20 seconds (Appendix 1). When couples were together, both adult males and females excavated (Appendix 1). In another event (19 October 2018), an adult male otter excavated two different craters in less than 30 seconds on the sandy substrate (Appendix 2).

Scent marking

Scent marking was defined as depositing urine and/or feces on the sandy substrate. Scent marking with urine inside the craters after digging was clearly identified during two events. This behavior was detected once with a solitary male and once with a couple. In one event (05 November 2019 at 07:04AM), the scent marking was done with feces, which were left clearly on the surface of the substrate by a male (Appendix 3). On another event (01 December 2018 at 06:22AM), we detected an interaction behavior between two adults; when a female clearly deposited her urine inside at least two craters that she had freshly dug, and the male immediately (< 8 second interval) deposited his urine on top of the female's urine in the same two craters (Appendix 1).

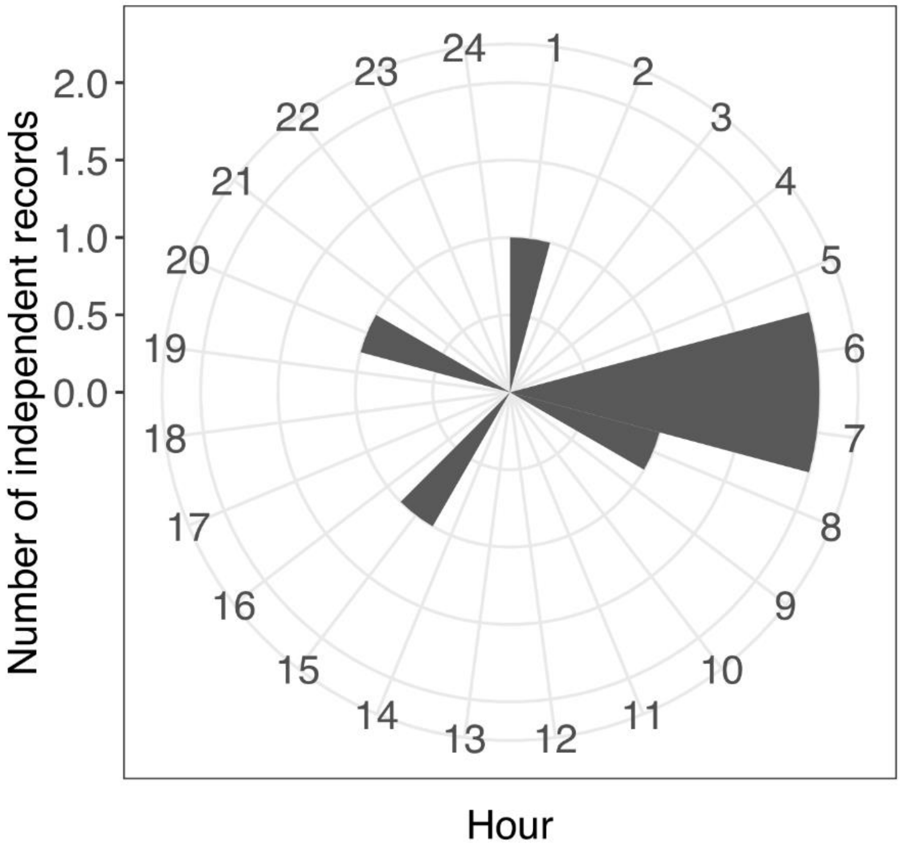

Figure. 2: Activity pattern of *Lontra longicaudis* monitored with camera traps in the eastern Brazilian Amazon. The number of independent records over a 24-h cycle presented in 1-h bin (e.g., 23 includes all photos between 23:00:00 and 23:59:59 h).

Rubbing

Rubbing was defined when an animal rubs its belly and genitalia/anal gland on the sandy substrate. Rubbing was identified in one event (19 October 2018 at

06:52AM) when an adult male exhibited belly and genitalia rubbing on the sandy substrate on the river margin twice (Appendix 2).

DISCUSSION

As far as we are aware this is the first study to document the digging followed by scent marking behavior in wild Neotropical Otters. Due to their secretive nature and the difficulty of directly observing individuals in the field (de Almeida and Ramos Pereira, 2017; Rheingantz et al., 2017) many behavioral aspects of this semi-aquatic species remain unknown. We first turn to discuss the low number of detections, and then explore information on activity patterns and number of simultaneously detected individuals. Finally, we discuss how the digging, scent marking, and rubbing behavior observed in our study helps to increase the knowledge of the species and inform both *in-situ* and *ex-situ* management and conservation initiatives.

We found a low detection rate (0.3 detections per 100 trap-days) of Neotropical Otters in our cameras located on islands and sand banks along 39 km of river. This low detection rate is perhaps surprising, considering the intensive sampling effort (2822 trap-days from 19 sites in 2018 and 19 sites in 2019), within a relatively short river segment (39 km) in our study. Thus, our results corroborate previous studies that found this species to be difficult to obtain direct detections in the field (Rheingantz and Trinca, 2015; de Almeida and Ramos Pereira, 2017; Rheingantz et al., 2017). This could be a reflection of the fact that our cameras were installed in dry exposed areas along the river, which are not necessarily frequently used by Neotropical Otters, a species that depends predominantly on water bodies for feeding and foraging activities (Kruuk, 2006). Moreover, camera trap studies only had higher number of detections of Neotropical Otters when cameras were placed facing otter dens (Rheingantz et al., 2016). As our study area has low levels of anthropogenic disturbance (Norris and Michalski, 2013; de Oliveira et al., 2015; Quintana et al., 2019), and has the presence of the entire community of vertebrates (Michalski et al., 2015; Paredes et al., 2017), we would expect that Neotropical Otters could be more easily detected in our region when compared with more fragmented and disturbed areas in the Brazilian Amazon (Michalski and Peres, 2005), Pantanal or Atlantic Forest (Rheingantz et al., 2016).

Although our records do not fully represent the activity pattern of *L. longicaudis* in our study area, our results with records obtained during both day and night, corroborate the plasticity of activity already described in the literature (Nakano-Oliveira et al., 2004; Rheingantz et al., 2016). But we found otters to be more active during the day, with a peak of records during the first hours of the morning, which was already recorded in the Brazilian Atlantic forest and in the Pantanal (Rheingantz et al., 2016). Similarly, most of the records obtained in our study were composed of single adults walking and inspecting islands and sand banks along the river. The solitary behavior of this species, with only occasional records of adults in pairs or in small groups of females and their cubs was already reported in the literature (Rodrigues et al., 2013; Rheingantz and Trinca, 2015; Rheingantz et al., 2017).

Although otters are known to use scent marking to communicate (Kruuk, 1992, Ben-David et al., 2005), and Neotropical Otters (*Lontra longicaudis*) are already known to use scent marking as communication between individuals (Rheingantz and Trinca, 2015; Rheingantz et al., 2017), the behavior of digging and depositing urine in exposed craters has not been described before. Neotropical Otters deposit feces and mucus in conspicuous locations such as rocks, fallen tree trunks, and sand banks along rivers (Dunstone and Strachan, 1988; Rheingantz et al., 2016; 2017), but until now, the behavior of individuals depositing urine on top of each other's, which is probably linked with sexual behavior (Larivière, 1999) has not been recorded previously. Similarly, rubbing behavior, with males rubbing belly and genitalia on sandy substrates along river margins has not been described before. Rubbing behavior in mammals is less frequently documented in the literature when compared to marking with urine or feces but some studies already documented rubbing in mammals (Bel et al., 1999; Allen et al., 2014; 2017).

CONCLUSIONS

Our study contributes with new information on the behavior of this species of river otter, which has lack of information on behavior ecology (de Almeida and Ramos Pereira, 2017). We also bring information that could potentially help animal welfare in zoos, as sandy substrate can be important for otter communication. Animal welfare has been a current focus in research and information coming from elusive and free-ranging animals such as Neotropical Otters seems to be crucial and difficult to obtain. Thus, we believe our study can benefit conservation *ex-situ* and contribute with better knowledge on ecological behavior of Neotropical Otters.

Finally, our data on otter use of islands and sand banks along Amazonian rivers suggest that studies based solely on indirect signs (e.g., feces, footprints) to predict habitat use and anthropogenic effects on Neotropical Otters may be biased and must be evaluated with caution. Ideally, studies must use a combination of different methods using direct and indirect detections to model habitat use by river otters (Gomez et al., 2014), which may reduce biases related with the lack of detection of otters in easily washed records such as footprints.

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APPENDICES

Appendix 1 - Digging and scent marking behavior of *Lontra longicaudis*. Two adults (one female and one male) scent marking the margin of a sand bank along the river. The female excavates and urine in the burrow and after the male urines on top of the female’s urine.

Link to video file

Appendix 2 - Digging, scent marking, and rubbing behavior of *Lontra longicaudis*. One adult male scent marking and rubbing its belly and genitalia on the margin of a sand bank along the river.

Link to video file

Appendix 3 - Digging and scent marking behavior of *Lontra longicaudis*. Two adults (one female and one male) scent marking the margin of a sand bank along the river. The male excavates, smells, and deposit and left feces in a clear place on the substrate.

Link to video file

RÉSUMÉ

NOUVEAU COMPORTEMENT DE MARQUAGE OLFACTIF CHEZ LA LOUTRE À LONGUE QUEUE (*Lontra longicaudis*) DANS L’EST DE L’AMAZONIE BRÉSILIENNE

Le comportement de marquage olfactif chez les mammifères est lié à la fois à la communication inter et intra-spécifique. Plusieurs espèces de loutres sont connues pour communiquer via un marquage olfactif, mais un marquage olfactif d’un couple n'a pas été observé chez la loutre à longue queue (*Lontra longicaudis*). Nous obtenons des observations de terrain sur le comportement de marquage olfactif des loutres à longue queue, durant deux ans, à l'aide de pièges photographiques, le long des cours d'eau dans l'est de l'Amazonie brésilienne. Nos résultats révèlent l'utilisation de substrats sableux sur les îles et les berges des rivières pour la communication intra-spécifique entre loutres. La plupart des enregistrements (62,5%) proviennent d'adultes solitaires. Nous observons plusieurs enregistrements distincts de loutres adultes creusant pour flairer l'urine et le comportement de couple de mâles urinant sur l'urine fraîche de la femelle dans des dépressions peu profondes récemment creusées. Nous démontrons également la plasticité comportementale de cette espèce mise en évidence par des pièges photographiques enregistrant l'activité terrestre de jour comme de nuit. Nos résultats contribuent à améliorer la connaissance du comportement de cette espèce de loutre dans la nature et peuvent potentiellement être appliqués pour améliorer le bien-être ex situ des loutres captives.

RESUMEN

NUEVO COMPORTAMIENTO DE MARCACIÓN OLOROSA DE LA NUTRIA NEOTROPICAL (*Lontra longicaudis*) EN LA AMAZONIA ORIENTAL BRASILERA

El comportamiento de marcación olorosa en los mamíferos se relaciona tanto con la comunicación inter-específica como la intra-específica. Varias especies de nutrias se sabe que se comunican mediante marcación olorosa, pero la marcación olorosa por parejas no ha sido documentada en la Nutria Neotropical (*Lontra longicaudis*). Obtuvimos observaciones de terreno del comportamiento de marcación olorosa en Nutrias Neotropicales a lo largo de dos años utilizando cámaras-trampa a lo largo de cursos de agua en la Amazonía oriental brasilera. Nuestros resultados revelan el uso de sustratos arenosos en islas y márgenes de ríos para la comunicación intra-específica entre nutrias. La mayoría de los registros (62.5%) fueron de adultos solitarios. Documentamos múltiples registros independientes de nutrias adultas excavando para marcar con olor, con orina, y comportamiento de pareja de machos orinando encima de orina fresca de hembras en cráteres poco profundos recién excavados. También demostramos la plasticidad comportamental de esta especie, evidenciada por los registros con cámara-trampa, de actividad terrestre tanto diurna como nocturna. Nuestros resultados contribuyen a mejorar el conocimiento del comportamiento de esta especie de nutria en la naturaleza, y pueden ser potencialmente aplicados al mejoramiento del bienestar *ex-situ* de nutrias en cautiverio.

SHORT COMMUNICATION

INCIDENTAL SIGHTINGS OF THE VULNERABLE ASIAN SMALL-CLAWED OTTER (*Aonyx cinereus*) IN ASSAM, INDIA: CURRENT AND FUTURE THREATS

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Abstract: The Asian Small-clawed Otter (*Aonyx cinereus*) is the smallest otter species in the world and is listed as Vulnerable due to the large number of threats they face, ranging from habitat loss to hunting. This report highlights the importance of Asian Small-clawed Otter habitats in Assam, India, through four incidental sightings; two with photographic records.

Citation: Menzies, R.K. and Rao, M. (2021). Incidental Sightings of the Vulnerable Asian Small-Clawed Otter (*Aonyx cinereus*) in Assam, India: Current and Future Threats. *IUCN Otter Spec. Group Bull.* **38** (1): 38 - 44

Keywords: *Aonyx cinereus*, Asian Small-clawed Otter, Assam, India, Wildlife Management

INTRODUCTION

The Asian Small-clawed Otter (*Aonyx cinereus*) is listed as Vulnerable according to the IUCN Red List and India is the westernmost range for the species globally (Wright et al., 2015). The Asian Small-clawed Otter is one of three species of river otters found in India, the others being the Eurasian Otter (*Lutra lutra*) and the Smooth-coated Otter (*Lutra perspicillata*). In India, the Asian Small-clawed Otter's range extends from north to northeast India, a separate range in south India which includes the Western Ghats (Hussain et al., 2011), and most recently the state of Odisha (Mohapatra et al., 2014). Asian Small-clawed Otters are given the highest level of protection under the Wildlife Protection Act (1972) in India; however, there are still threats which impact the populations in northeast India. Globally, this threatened species is impacted by a number of causes which contribute to their declining populations: hunting, logging, overfishing, dams, water pollution, and development of infrastructure in or near their habitat (Wright et al., 2015). Hunting of the species is prevalent in northeast India, where otters continue to be poached in Arunachal Pradesh and transported to Assam for sale at extremely high prices (Datta et al., 2008; Aiyadurai et al., 2010). Poaching potentially extends to the state of Assam as well. The Asian Small-clawed Otters are primarily hunted for their pelts, which has a high demand in the colder regions of northeast India, Tibet, and China. This report elucidates our sightings of Asian Small-clawed Otters from Assam, India, threats observed, and an insight into future threats we accrued by speaking to local community members.

STUDY AREA

Between November 2018 and March 2019, we surveyed the forested pools and streams for the Endangered White-winged Duck (*Asarcornis scutulata*) in Assam, India. All Asian Small-clawed Otter sightings mentioned here are incidental and were recorded during our surveys. The project focused on a state-wide survey for the White-winged Duck including repeated visits to sites over five months of fieldwork. The Asian Small-clawed Otter is a predominantly nocturnal and crepuscular species, observations from northeast India are limited to those captured on camera-traps with few real-time observations. Explicit sighting records of the species from particular locations in Assam are rare and could be important to depict accurate distribution ranges and numbers. From Nameri Tiger Reserve, for example, surveys from 1999-2010 only recorded the Eurasian Otter and Smooth-coated Otter (Saikia and Saikia, 2012). We hope that the sightings reported here from Assam (Fig. 1) add to the literature and conservation efforts of Asian Small-clawed Otters in India.

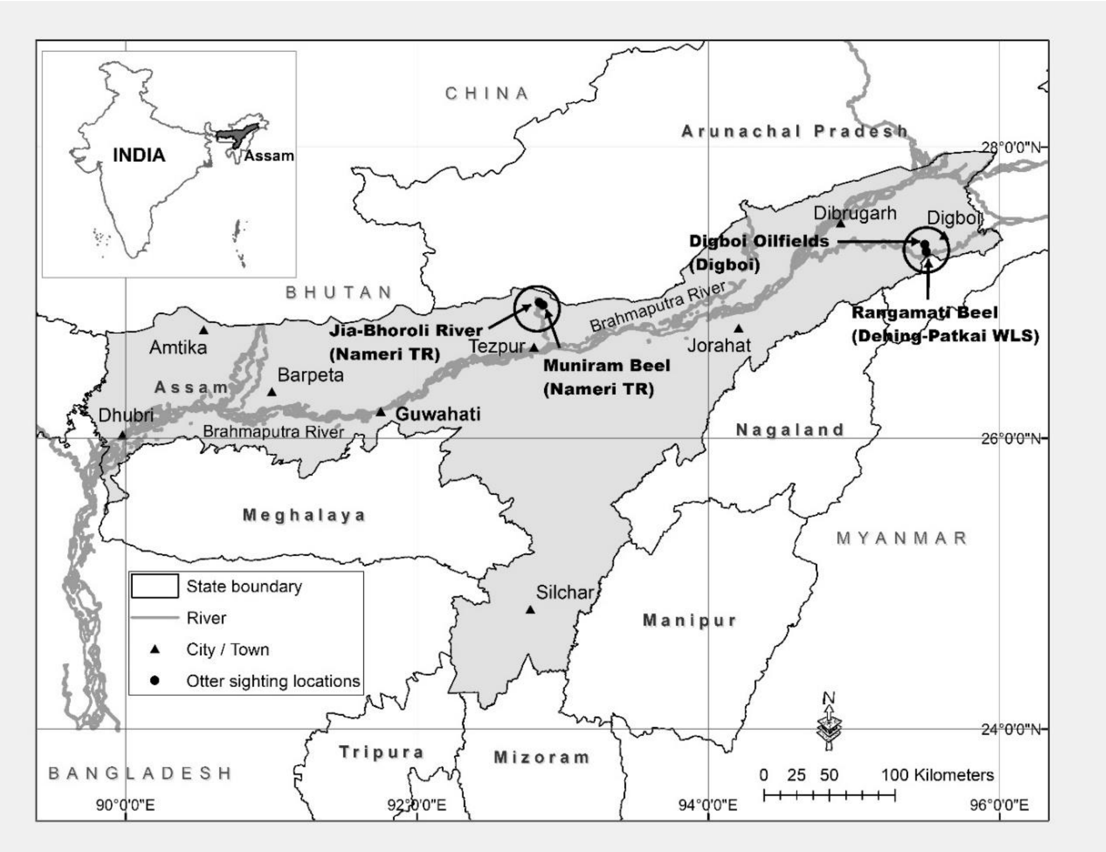

Figure 1: A map of Assam, India with the four sighting locations shown in black text.

OBSERVATIONS

The first sighting was on 03 November 2018 at approximately 09h30 at Muniram Beel in Nameri Tiger Reserve, western Assam (26° 55'N, 92° 52'E). There were three individuals on the bank of the pond and they allowed us to observe them for over 20 minutes. From the shore, in what appeared to be a den, they got into the water and foraged for a while. The three otters were constantly swimming around but were always close to each other. They then climbed on top of a fallen tree trunk, perhaps to sun themselves, where we were able to photograph them (Fig. 2). These otters were fairly active that morning and according to the Forest Department staff and our field assistant, they are rarely seen by visitors and almost impossible to photograph. The forest pool site is one of two main waterbodies inside the protected area, and Muniram Beel is afforded higher protection as it is not accessible to tourists. The number of researchers working in the area are also low and hence these notes are important for the area. The water in the pond was clear and it appeared to have a healthy fish population. There was short, shrubby vegetation along the sides of the pond which likely provide security for otters to feed there. We also observed fallen logs in the water in around the *beel* which may be preferred by the otters. There is an anti-poaching camp close to the site and therefore experiences low levels of human disturbance at the pond. It is a relatively undisturbed location and if maintained, could be of regular, long-term importance to Asian Small-clawed Otters in the forest.

Figure 2: Three Asian Small-clawed Otters *Aonyx cinereus* seen on a fallen log at Muniram Beel, Nameri National Park, Assam.

On 04 November 2018 at 07h20, also at Nameri Tiger Reserve, a pair of otters were seen in the main river, Jia-Bhoroli (26º 56'N, 92º 50'E), which forms the southern border of the Tiger Reserve, thus separating it from the reserve forest on the other bank. After crossing the river by boat to enter the park, we were walking towards the forest edge on a sandy stretch where we noticed two otters in the water. They were feeding in the middle of the river, in a stretch which did not have too many rapids. The otters then found a log in the river to climb (Fig. 3). Due to the boat rides, that section of the river is inundated by a number of visitors. Not all visitors enter the park but their impact can be seen near the water. The otters also had to tolerate garbage in the water and on the banks. This area is also fished by the locals, is prone to frequent boat traffic, tourists who river raft and fish, and has a significant level of human presence which could deter otters. We even encountered villagers who were fishing close to where the otters were first seen. Unlike Muniram Beel, the Jia-Bhoroli River seems a less likely place to observe otters regularly based on the human presence observed along the river.

Figure 3: A pair of Asian Small-clawed Otters *Aonyx cinereus* seen in the Jia-Bhoroli River at Nameri National Park, Assam.

The third sighting of Asian Small-clawed Otters took place at Rangamati Beel in Soraipung on 30 November 2018 at approximately 15h00. Rangamati Beel is part of the Dehing-Patkai Biosphere Reserve (27º 17’N, 95º 30’E) in Dibrugarh district, Assam. While conducting a habitat survey of the pond, we observed two otters swimming in the water. We did not notice them feeding and were more likely playing in the water. They were alerted to our presence because of the dry leaves underfoot and began swimming away from us and took shelter in a small island in the pond. The undergrowth at the point of sighting made it impossible to get a photograph; however, all four observers got a clear look at the two otters. Rangamati Beel is one of the largest, permanent waterbodies in the protected area (Fig. 4). It gets its name from the murky, muddy water and is relatively rich in terms of biodiversity. Several birds occupy this forested pool and a number of reptiles were seen on many occasions, including Common Indian Monitors (*Varanus bengalensis*) and Assam Roofed Turtle (*Pangshura sylhetensis*). During this same survey, we also saw the endangered White-winged Duck fly from one end of the pool to the other. Leopards are also known to regularly visit this pond. This *beel* is very important for these species; however, we did also observe signs of fishing around the water. There is road access until about a kilometre away from the pool and unfortunately, according to the locals, there are plans to construct another road which would run right beside Rangamati. This would be extremely damaging to the landscape and the rare species dependent on it, including the Asian Small-clawed Otters.

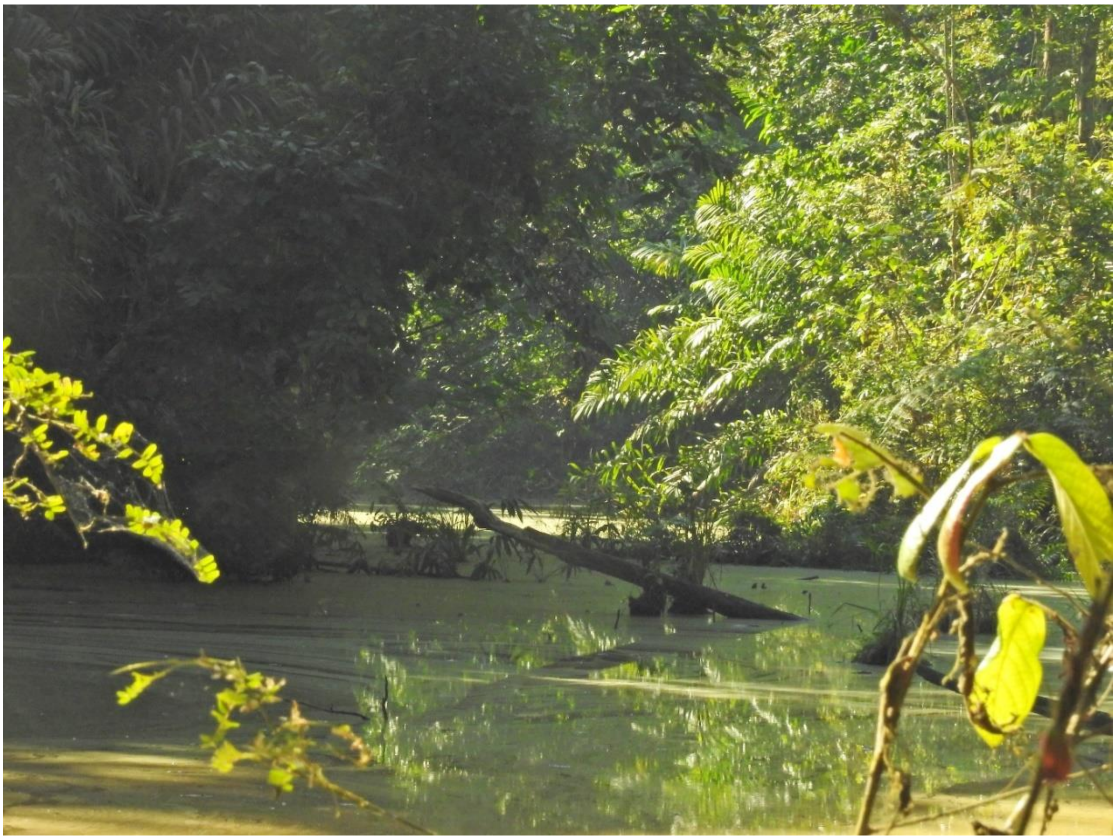

Figure 4: A photograph to show the habitat occupied by the Asian Small-clawed Otters at Rangamati Beel in Dehing-Patkai Wildlife Sanctuary, Assam.

On the 09 December 2018 at approximately 08h00, we observed a lone Asian Small-clawed Otter in a small stream at the Digboi Oilfields in the district of Tinsukia, Assam (27º 20'N, 95º 29'E). The stream is located right opposite a boiler unit which consists of a large reservoir inside Digboi Oilfields. Excess water from the reservoir flows into this particular stream. The two are separated by a road and the water flows below the road through a canal and joins the stream. The otter was seen for a few seconds swimming near the roots of a tree growing at the edge of the stream. It could not be photographed but it sensed our presence before swimming away and hiding. This location was very close to the boiler unit and is one of the busier roads in the area. We later left the stream to continue our work and when we returned, we saw over ten fishermen at the stream, diverting the water by moving the rocks and catching fish with traps. Some fishermen were at the opening of the possible tree den and the part of the stream where the otter was seen was now turbid because of the water diversion and movement of fishermen. We later informed the Forest Department of these observations. There are several forested streams in the area and we requested more monitoring of this stream in particular since otter presence was confirmed. We also suggested some signage on the road to warn against illegal fishing.

DISCUSSION AND CONCLUSIONS

The incidental sightings of Asian Small-clawed Otters in Assam are positive for the species, not simply as an indication of their presence, but also to suggest how these areas can be maintained and improved. The current threats we observed include high levels of fishing in otter habitat (and the subsequent disturbance), garbage in the rivers, and uncontrolled human disturbances. It is also important to note that the high level of fishing does not only impact the food resources of the otters but also severely affects their habitat. In winters, it is common practice in several parts of Assam, including the Dehing-Patkai range which has other ongoing threats (https://www.hindustantimes.com/india-news/large-parts-of-assam-s-elephant-reserve-mined-without-wildlife-nod/story-NFh0yNncJ3PiUePrlUGJ7J.html), to empty small waterbodies such as forested pools in order to catch all the fish in a pond. This unsustainable method of fishing not only depletes fish populations but is also detrimental to the otter's habitat. The main future threat observed was at Rangamati Beel where road construction could damage the entire landscape. Asian Small-clawed Otters are an important species for these forested pools and to the riverscapes of northeast India. It is crucial that more species-specific surveys are conducted in the region for otters. Conducting research on these ecosystems in the future should also address threats and how it can be mitigated. The requirements outlined in Prakash et al. (2012) also holds true for the otter populations in Assam since much of it is within human-modified landscapes or are on the verge of being modified. Hunting of otters will be difficult to tackle given the ever-increasing demand in Assam; however, awareness programmes on the importance of the species could slow down the negative impacts on otters. A rigorous plan which involves surveys, research, and developing a management plan could be highly beneficial for the species.

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RÉSUMÉ

OBSERVATIONS ACCIDENTELLES DE LA LOUTRE CENDRÉE D'ASIE (*Aonyx cinereus*), VULNÉRABLE, DANS L'ASSAM, EN INDE: MENACES ACTUELLES ET FUTURES

La loutre cendrée d'Asie (*Aonyx cinereus*) est la plus petite espèce de loutre au monde et est classée vulnérable en raison du grand nombre de menaces qui pèsent sur elle, allant de la perte d'habitat à la chasse. Ce rapport souligne l'importance des habitats de la loutre cendrée d'Asie dans l'Assam, en Inde, à travers quatre observations accidentelles dont deux avec des archives photographiques.

RESUMEN

AVISTAJES INCIDENTALES DE LA VULNERABLE NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA (*Aonyx cinereus*) EN ASSAM, INDIA: AMENAZAS ACTUALES Y FUTURAS

La Nutria de Uñas Pequeñas Asiática (Aonyx ciniereus) es la especie de nutria más pequeña del mundo, y está listada como Vulnerable, debido al gran número de amenazas que enfrenta, desde pérdida de hábitats hasta cacería. Este informe destaca la importancia de los hábitats de Nutria de Uñas Pequeñas Asiática en Assam, India, a través de cuatro avistajes incidentales; dos de ellos con registros fotográficos.

SHORT COMMUNICATION

ASSESSING THE OCCURRENCE AND RESOURCE USE PATTERN OF SMOOTH-COATED OTTERS *Lutrogale Perspicillata* GEOFFROY (CARNIVORA, MUSTELIDAE) IN THE MOYAR RIVER OF THE WESTERN GHATS BIODIVERSITY HOTSPOT

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Abstract: Understanding the factors affecting presence and habitat requirements of threatened species is fundamental to their conservation. Patterns of occurrence and resource use by the vulnerable Smooth-coated otter were examined by sampling Moyar River in the Western Ghats biodiversity hotspot of India between 2015 and 2017 for otter spraints, tracks, dens and grooming sites. An occurrence-based framework was used to determine the influence of environmental covariates on otter detectability. Information on environmental parameters was recorded every 400 meters along the riverbanks in post-monsoon, winter, and summer seasons. Smooth-coated otter occurrence was high before the summer but waned drastically after monsoon when increased water levels reduce detectability of otters by washing away signs of their presence. Otter occurrence and resource use patterns were influenced by river substrate, habitat characteristics, riverbank traits and forest types. Otters prefer wider rivers, but avoided rocky areas with shallow water. Resource use patterns were determined by habitat traits and disturbance in all three seasons. Various forms of disturbances adversely affected the otter occurrence. Restoration of degraded habitats is necessary to improve the long-term conservation prospects of otters. Regional otter conservation plans need to be species-specific to help maintain the ecological balance of Moyar River ecosystem.
Citation: Narasimmarajan, K., Hayward, M.W., and Mathai, M.T. (2021). Assessing the Occurrence and Resource Use Pattern of Smooth-Coated Otters *Lutrogale Perspicillata* Geoffroy (Carnivora, Mustelidae) in the Moyar River of the Western Ghats Biodiversity Hotspot. *IUCN Otter Spec. Group Bull*. **38** (1): 43 - 58
Keywords: otter; occurrence; conservation; vulnerable; Moyar river; Western Ghats

INTRODUCTION

Freshwater ecosystems provide a wide range of goods and services, and housing a rich biodiversity (Newman and Griffin, 1994). In many Asian countries, human population levels have steadily increased during the last century; however existing rural development programmes have not adequately addressed key issues, such as poverty, forcing people to become increasingly dependent on rapidly depleting natural resources (Sathyanarayana, 1997). Freshwater ecosystems suffer from increased levels of point and non-point sources of pollution and developments (Raj, 1941). Increased anthropogenic impacts also pose a major threat to species that dependent on freshwater ecosystems (Ruiz-Olmoand Consalbez, 1997).

Otters are often the apex predator in freshwater and wetland ecosystems (Kruuk, 1995). However, throughout their ranges, otters are losing their habitat as a result of the construction of dams and barrages, reclamation of wetlands for settlements and agriculture, reduction in prey biomass, poaching, and contamination of waterways by pesticides and weeds (Raj, 1941).These activities have a profound impact on aquatic food webs and the habitat relationships of species occurring there (Hussain et al., 2008).

Smooth-coated otters (*Lutrogale perspicillata*) are the largest Asian otter species and are categorized as Vulnerable in the IUCN Red List (Nawab and Hussain, 2012a) and are on Appendix II of CITES (Hussain and Choudhury, 1997).The existing populations of the three species of otters in India (the other two being Small-clawed otter (*Aonyx cinerea*) and Eurasian otter (*Lutra lutra*)), and their habitat have been surveyed very infrequently (Gupta et al., 2016). The minimal understanding of otter ecology we have is on gross habitat assessments, and there is a suggestion of a rapid decline of otter populations through habitat loss and intensive poaching (Raj, 1941; Hussain, 1996; Hussain and Choudhury, 1997; Anoop and Hussain, 2004; Nawab and Hussain, 2012a,b). Previous work on otters in India has mostly involved observations on captive animals (Hussain and Choudhury, 1997) and occasional notes on their occurrence from different parts of the country (Nawab and Hussain, 2012a).

The Moyar is a significant perennial river in the Western Ghats biodiversity hotspot of India and is thought to support a sizable otter population. However, indiscriminate fishing activities, pumping of river water for irrigation farming, hydro-electric projects and mesquite invasion along the riverbanks are affecting the occurrence and resource use patterns of otters (Narasimmarajan et al., 2018). There is no information on otter occurrence and resource use in this region, which hinders appropriate conservation action being taken.

MATERIALS AND METHODS

Study area

The Moyar River in the Western Ghats biodiversity hotspot in India flows through several protected areas (Mudumalai Tiger Reserve, Sathyamangalam Tiger Reserve, Nilgiri North and South Divisions; Fig. 1).The upper reaches of the river receive ~5,000 mm of rainfall, whereas the down part reaches receive ~824 mm rainfall annually (Puyravaud and Davidar, 2013).The minimum and maximum annual average temperatures in this region vary from 14 ˚C – 30 ˚C in higher elevations, and 25 ˚C – 38 ˚C in the lower elevations (Narasimmarajan et al., 2018). Elevation of the river varies from 250 masl (Bavanisagar Dam) to 2,054 masl (Pykara Dam) (Champion and Seth, 1962). The landscape supports large populations of tiger (*Panthera tigris*), leopard (*Panthera pardus*), elephant (*Elephas maximus*), otters (*Lutagale perspicillata*; *Aonyx cinerea*) and endangered vultures (*Gyps benghalensis; Gyps indicus; Neophron percnopterus; Aegypius monachus)* (Narasimmarajan et al., 2018). The river is an important source of irrigation for thousands of hectares of agricultural land and supports the livelihood of more than a million people (Puyravaud and Davidar, 2013). However, this river ecosystem faces many threats, such as agricultural runoff, hydroelectric projects, unrestricted fishing activities, pesticides and spilling of motor oil (Narasimmarajan et al., 2018). In addition, mesquite continues to invade the river gorges, catastrophically impacting native vegetation (Kumar and Mathur, 2014).

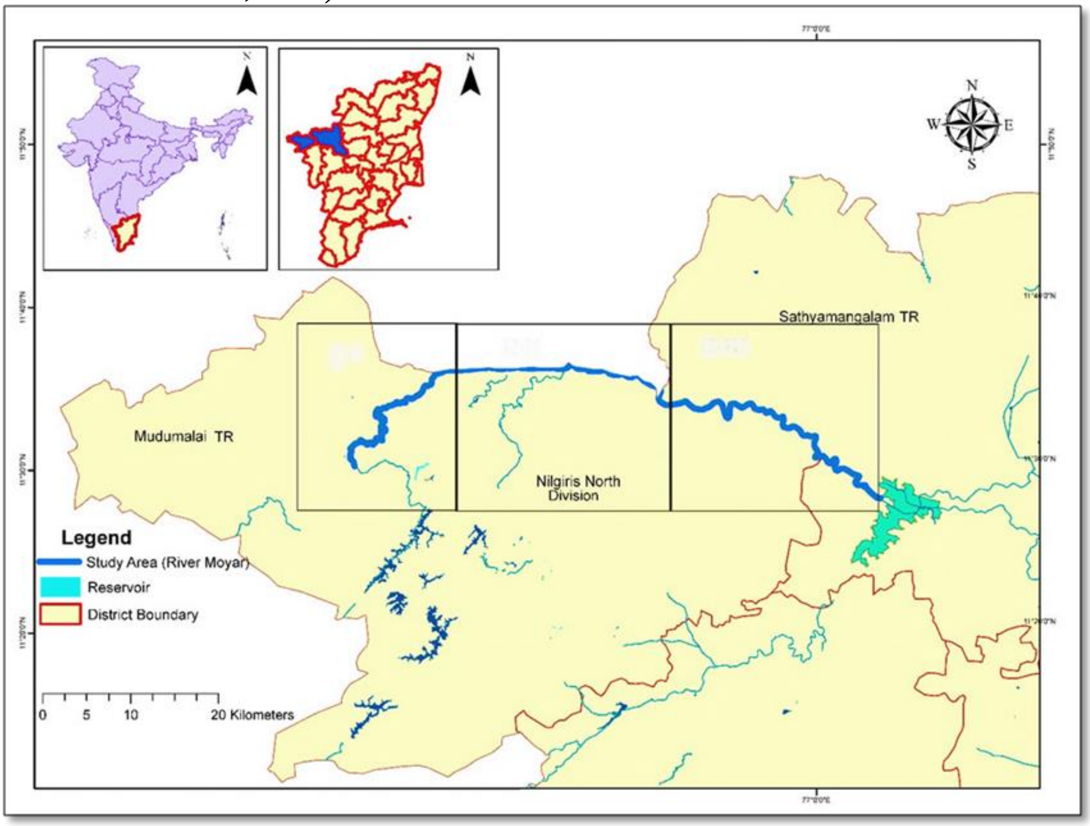

Figure1. Map showing the Moyar River, Western Ghats; Biodiversity hotspots

Data collection

We aimed to investigate the distribution and resource use of smooth-coated otters in the river Moyar study region using the survey methods of Hussain and Choudhury (1997); Brzezinski and Jedrzejewska (1993); Anoop and Hussain (2004) and Nawab and Hussain (2012a). The entire River Moyar and its tributaries were divided into 6 km segments (minimum otter home range based on Hussain and Choudhury, 1997) using geographical information systems (Fig. 1). Data on environmental parameters and otter signs (spraints, tracks, dens and grooming sites) were recorded every 400 m (random stratified, at significant crossing/access points) and we consider each 400 m transect a study plot. The data was collected between 2015 and 2017.

A team of four researchers conducted the survey by walking along both riverbanks, searching for otter signs. A few inaccessible areas (n=4) were excluded due to safety concerns. In each survey (post-monsoon, winter and summer) season, the plots where spraints, tracks, grooming plots, dens and other signs of otter presence were found defined as a 'used/positive sites. A new plot was considered as such only when sprains were separated by >15 m (Melquist and Hornocker, 1983; Newman and Griffin, 1994; Medina, 1996). For the estimation of habitat availability, each plot was categorized as rocky stretch, sandy stretch, muddy stretch, clayey stretch and alluvial stretch.

In each survey season, data on environmental parameters and disturbance that were considered potentially important to otters were collected from each plot

(Macdonald and Mason, 1983; Brzezinski and Jedrzejewska, 1993; Anoop and Hussain, 2004). Opportunistic observations of otters during the course of the surveys were also recorded and their group size, structure and activity were noted.

Data analysis

A detection history was created based on whether otter signs were detected (1) or non-detected (0) for each season at each 400 m long study plot. The covariate data collected for available and used plot was organized in sample-habitat parameter matrix for post monsoon, winter and summer seasons respectively. The raw data matrix was arranged into proportionate and continuous data, which had to be suitably transformed via arcsine and log transformation and standardized following Zar (1984). Factor analysis was used to reduce the dimensionality of the habitat variables. The first three factors (predictors) were used for interpretation as these explained maximum variations in the data set, and Pearson product moment coefficient as the input and a varimax rotation of the factors. Simple cross-tabulations and χ^2 statistics were calculated for the detection of possible relationships between resource variables (i.e. the presence/absence of different environmental traits, and presence/absence of sprainting activity) and auto-correlated null variables were dropped due to their non-aligned influence on the sprainting activity (Van Emden, 2008).Pearson's correlation was used to subset the null deviations, and the constant-only model used the significant covariates for further analysis (MacKenzie et al., 2002; Kruuk, 1995). Significant associations between habitat traits, and the presence or absence of sprains are shown in Table 1.

Table 1. Summary of the significant results of χ^2 analysis using cross-tabulation and Pearson's correlation tests.

Land cover type	Grid cell Neighborhood	χ^2	Type of association	Significance (*P*)
Rocky	20 x 20	0.37	+	0.925
Dry leaf litter cover	%	-0.35	-	0.045 *
Elevation/altitude	meters	0.31	-+	0.066
Canopy cover	%	0.51	- +	0.048 *
Bank vegetation	%	-0.43	-	0.871

* A significant degree of freedom χ^2 value indicates that there was a significant association between the presence or absence of spraints and that habitat type. A positive association of otter sprainting activity with a particular habitat types are indicated by a plus sign and a negative association by a minus sign in the table.

Spraints are likely to be detected more often than expected where rocky and loose sand occurs in the immediate vicinity of a survey plot (White et al., 2003) and may be overlooked in dense vegetation, etc. Spraints are likely to be found less often than expected at plots with grass either in the surrounding land or the immediate vicinity. The land cover variables that were significant were included with those representing stream order, stream gradient and habitat characters in the logistic regression analysis (White et al., 2003).Global logistic regression model (*Z-value*) including variables relating to habitat, the physical characteristics of the river and surrounding vegetation cover was able to predict the presence or absence of otter sprainting at different survey plots with an accuracy of 92% using software R (R Core Team, 2018).

RESULTS

Resource availability

Fourteen categories of covariates were obtained for the study area. At the landscape level, the mean ± SE of substrate variable 'hard sand' constituted 7.40 ± 0.7 followed by rocky stretches composed of boulders 4.51 ± 0.6, loose sand stretches 2.47 ± 0.1, while alluvial stones constituted the least at 1.12 ± 0.3. Habitat variables were consisted of canopy cover 18 ± 2.7%, dry leaf litter cover 6.49 ± 0.9, bank vegetation 4.42 ± 0.4 and average grass height 3.97 ± 0.5. River characteristics represented attitude/elevation 464.5 ± 6.7 followed by water current 11.5 ± 1.9, river depth 2.6 ± 0.1 and river width 2.06 ± 0.3 (Table 2).

Table 2. List of environmental variables/covariates collected to assess factors affecting the Smooth-coated otter occurrence and discrimínate function analysis.

Variables	Description	Data type	Range
Type of River substrate (%)	Approximate percentage of total (100 m x 15 m) plot covered by sand, rock, boulders, stone, mud, clay or alluvial deposits. Values attributed by eye	Categorical	0.00 -100
Depth of the river (m)	The depth of the river was measured at one point at each plot plot using Metered Pole and the mean depth was calculated.	Scalar	0.20 – 8.0
River width (m)	The width of the river was measured at one point each plot plot using Laser Range Finder and the mean width was calculated.	Scalar	3.0 - 350
Water current (score)	The most frequent flow velocity per plot was visually assigned as 1-stagnant, 2-slow, 3-fast	Categorical	1 - 3
Water quality (score)	The quality of water was assessed through visually as 1-turbid and 2-clear	Categorical	1 - 2
Riverbank slope types (score)	1-Gentle, 2-moderate and 3-steep. Measured using clinometers	Categorical	1 - 3
Shoreline vegetation (score)	Emergent riparian vegetation on shoreline sufficient to provide cover for otters while travelling or resting. Estimated by eye. 1-dense, 2-fair and 3-no/nil	Categorical	1 - 3
Distance of escape cover from shoreline (m)	Nearest distance from water's edge to shoreline vegetation which provides cover for otters. Measured using a measuring tape	Scalar	0.0 - 20
Canopy cover %	Percentage of canopy cover of each plot was estimated using two-wheeler rear mirror	Categorical	0.0 - 95
Dry leaf litter cover %	Percentage of dry leaf litter cover was visually estimated	Categorical	0.0 - 100
Avg. grass/ herb height (ft)	The extent of grass and herbs cover in the plot estimated by eye	Scalar	0.0 – 5.0
Elevation (m)	Elevation of each plot was measured using global positioning system (Garmin)	Scalar	248 - 2054
Forest types	Entire river represents various forest types such as evergreen forests, riparian forests, deciduous forests, scrub forests, bamboo dominated riparian forests and mesquite area. Totally seven type of forests represent from total number of plots surveyed (100 x 15 m, 693)	Categorical	23 - 341
Disturbance (present/absent)	Evidence of destructive fishing practices such as various fishing nets, dynamiting, hydro-electric projects, removal of sand and boulders, domestic use of water using oil motor, oil mixing in the river, pesticide runoff mixing in the river and visible pollution. 0-absent and 1-present	Binary	0.0 – 1.0

Factors influencing the smooth-coated otter occurrence in post-monsoon winter and summer seasons in river Moyar

The principal component analysis had an efficiency of 93.41% of available and utilized plots. The model shows that the smooth-coated otter sprainting activities were positively related to sandy stretches with moderately steep bank slopes, with greater than average numbers of dead logs, and tall average grass height with no disturbance. Otter grooming plots occur along wider rivers at junctions where several streams join the main river, and they are least likely to occur near stagnant water. Conversely, tracks were only found in sandy stretches with no disturbance (Table 3). Sprainting activity varied significantly with seasons and decreased significantly with altitude/elevation and disturbance. The form of these relationships was unimodal.

Table 3. Principal component analysis showing the descriptive relationship between the signs, activities, and habitat covariates

Otter signs	**PCA 1**	**PCA 2**	***P*-value**
Spraints	1.6253	5.3013	$P<0.6$
Tracks	-0.67574	-4.9849	$P<0.5$
Grooming Plots	-0.94958	4.4547	$P<0.5$

The logistic regression explained 80.23% of the variance in otter presence. The post-monsoon otter occurrence were positively related to rocky stretches (z=0.1441, $P<0.01$), loose sand (z=1.6805, $P<0.01$), water current (z=0.4844, $P<0.01$) and altitude/elevation (z=0.633, $P<0.01$); but were negatively correlated with river width (z=-14.894, $P<0.01$) and dry leaf litter cover (z=-0.105, $P<0.01$). During winter, the otter occurrence were positively related with loose sand (z=1.0737, $P<0.01$) and rocky stretches (z=0.9215, $P<0.01$), but were negatively correlated with altitude/elevation (z=-15.668, $P<0.01$).In summer, otter occurrence was positively related to disturbance (z=0.7577, $P<0.01$), and negatively related with loose sand (z=-2.1742, $P<0.01$), water current (z=-3.3044, $P<0.01$) and altitude/elevation (z=-21.536, $P<0.01$; Table 4).

After the monsoon, otters preferred rocky areas with loose sand along with low altitude and fast flowing water current, and avoid narrow river plots, deep slope gorges (>65˚), dense vegetation cover and dry leaf litter cover (Fig. 2). In winter, otters maintain their preferences for rocky areas with loose sand at low altitude, but also avoid disturbance and higher elevation/altitude plots (Fig. 3).In summer, otters coexist with anthropogenic disturbance, but avoid loose and hard sandy areas, fast flowing water, and higher elevations in contrast to previous seasons (Fig. 4).

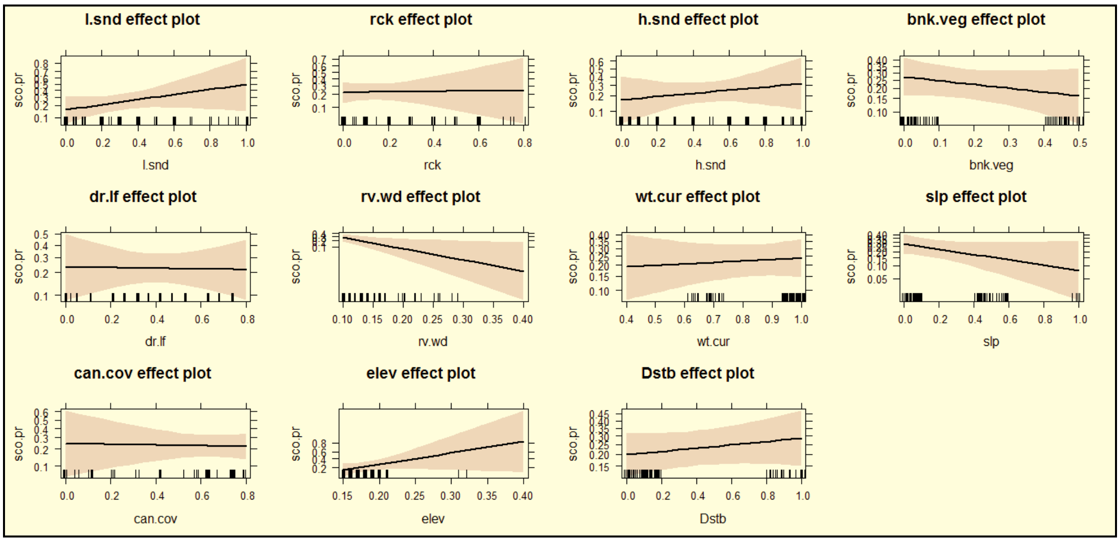

Figure 2. Effect plot showing the Global logistic regression model for predicting habitat suitability of a sample plot for the Smooth-coated otters in post monsoon in the river Moyar Western Ghats

Otter spraint occurrence varied with water current (i.e. fast, slow and stagnant), slow water current yields less spraints. No spraints were recorded at plots where mesquite had invaded (>89%).Spraints were most frequently recorded at plots with minimal shoreline vegetation (<48%).Although, more spraints (mean ± SE 0.57 ± 0.21) were recorded from plots with the presence of associated fauna (i.e. mugger crocodile *Crocodilus pardus*). Mostly otter spraints (0.37 ± 0.04) were recorded from plots that had loose sand and low disturbance.

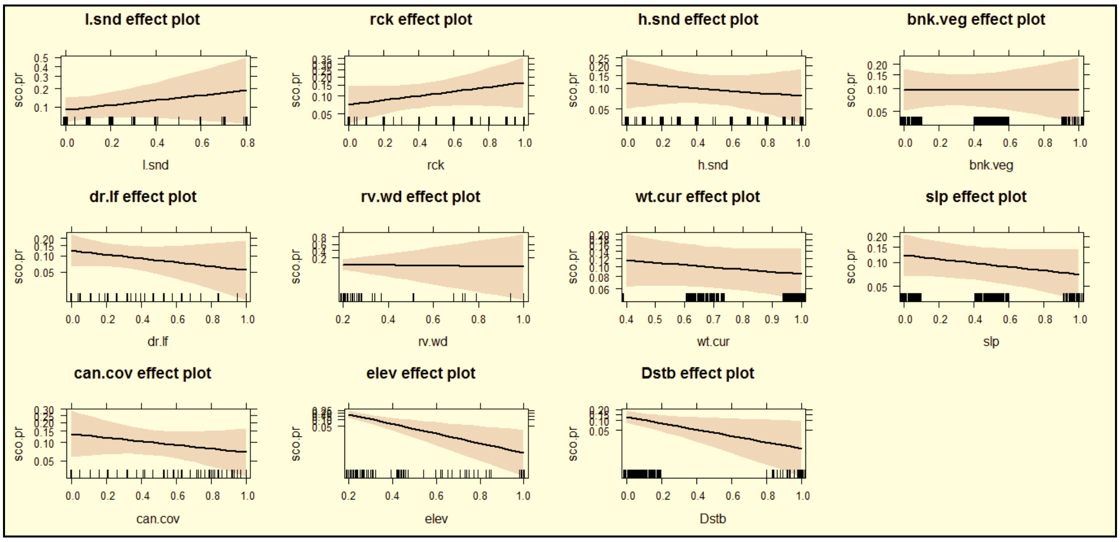

Figure 3. Effect plot showing the Global logistic regression model for predicting habitat suitability of a sample plot for the Smooth-coated otters in winter in the river Moyar Western Ghats

Table 4. Forward stepwise Global logistic regression analysis for Smooth-coated otters to testing the effect of 11 environmental variables on detected (n=116) and non-detected plots (n=577) at River Moyar locations. Only those explanatory variables are shown that were added to the model until R approached 1.0 (*P*>0.05).

Seasons	**Post monsoon[1]**				**Winter[2]**				**Summer[3]**			
Variables	Estimate	SE	z value	Pr(>|z|)	Estimate	SE	z value	Pr(>|z|)	Estimate	SE	z value	Pr(>|z|)
Intercept	-2.5214	2.4129	-1.045	0.296	1.1367	1.169	0.972	0.3310	9.5651	2.7010	3.543	0.0003**
l.snd	1.6805	1.2339	1.362	0.173	1.0737	0.971	1.105	0.2690	-2.1793	1.2248	-1.779	0.0751
rck	0.1441	1.5378	0.094	0.925	0.9215	0.77933	1.183	0.2370	-1.3106	1.2165	-1.077	0.2813
h.snd	0.8358	1.2023	0.695	0.487	-0.465	0.81726	-0.569	0.5692	-3.3044	1.1988	-2.756	0.0058**
bnk.veg	-1.3017	1.2444	-1.046	0.295	-0.023	0.70943	-0.034	0.9732	-1.8586	1.4531	-1.279	0.2008
dr.lf	-0.1205	1.2807	-0.094	0.925	-0.896	0.92078	-0.973	0.3304	-0.6172	1.0134	-0.609	0.5424
rv.wd	-14.984	6.4693	-2.316	0.021*	-0.38	2.41365	-0.158	0.8748	-1.3829	3.828	-0.361	0.7178
wt.cur	0.4844	1.0695	0.453	0.652	-0.569	0.67313	-0.846	0.3974	-3.5817	1.1339	-3.159	0.0015**
slp	-1.5117	0.9653	-1.566	0.117	-0.597	0.50374	-1.187	0.2353	-0.8963	0.8458	-1.06	0.2892
can.cov	-0.1733	1.173	-0.148	0.882	-0.755	0.83016	-0.91	0.3630	-2.7422	1.6238	-1.689	0.0912
elev	12.824	7.9864	1.606	0.108	-15.668	1.79627	-3.156	0.0016**	-21.5364	5.6454	-3.815	0.0001**
Dstb	0.4862	0.5052	0.963	0.335	-2.352	1.04524	-2.251	0.0244*	0.7577	0.6212	1.22	0.2225

The residual deviance of the constant-only model was [1-]181.8; [2-]133.5; [3-]157.7. The significance of the difference between the constant-only model and the models listed is indicated by asterisks (*, *P*<0.05; **, *P*<0.01; ***, *P*<0.001). Codes; l.snd- Loose sand, rck- Rocky, h.snd- Hard sand, bnk.veg- Bank vegetation, dr.lf- Dry leaf litter cover, rv.wd- River width, wt.cur- Water current, slp-Bank slope, can.cov- Canopy cover, elev- Elevation/altitude and Dstb- Disturbance.

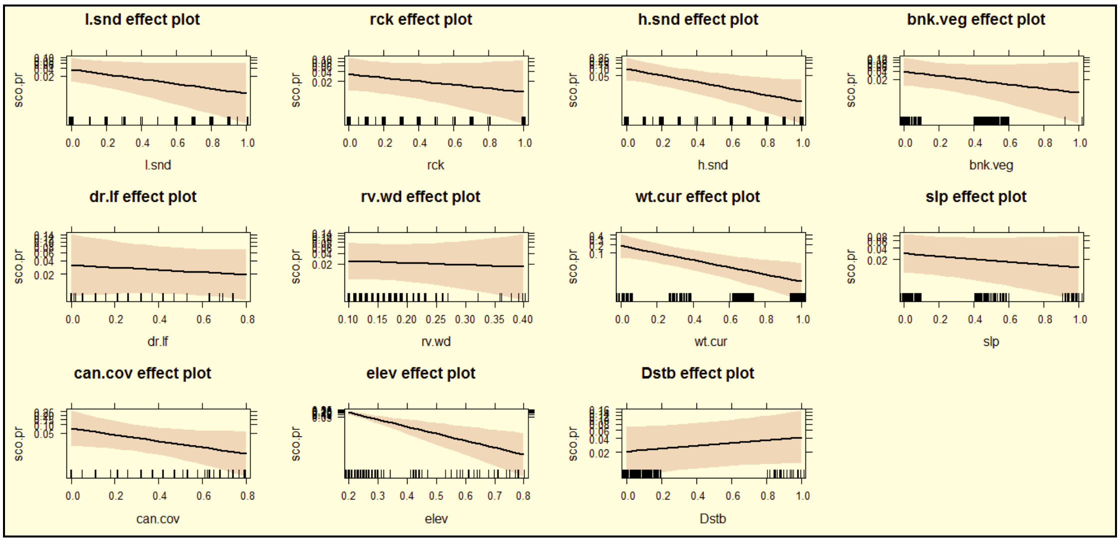

Figure 4. Effect plot showing the Global logistic regression model for predicting habitat suitability of a sample plot for the Smooth-coated otters in summer in the river Moyar Western Ghats

DISCUSSION

Effective and targeted conservation action requires detailed information about a species, its distribution, and ecology, as well as the distribution of threats that may adversely affect it. Our knowledge of the conservation requirements of otters remains low, and innovative means of gaining rapid insight into their status are needed to identify urgent conservation cases and inform environmental, agricultural, industrial and other development policies with appropriate biodiversity information in a timely manner.

Otters are excellent indicators and ideal symbols for wetland conservation (Gupta et al., 2016). Our detailed study along the river Moyar suggests that smooth-coated otters have very specific habitat preferences - favouring deep and wide stretches of the river, with gently sloping banks, and sandy and low vegetation cover. Conversely, otters in Periyar Tiger Reserve preferred banks that were gradually sloping usually at the mouths of small streams that joined the main lake (Anoop and Hussain, 2004). The smooth-coated otters in the River Moyar avoided shallow, steeper rocky banks. The number of streams joining the river (possibly influencing congregation of fish and vegetation density) was the most important factor in determining habitat selection by otters here. Hussain (1993) found that the distribution of den and prey availability is a pre-requisite for suitable habitat along the Chambal River, India. Melquist and Hornocker (1983) found that differences in habitat use by North American river otters (*Lontra canadensis*) resulted primarily from differences in habitat composition.

The preferred areas for smooth-coated otters in the River Moyar were characterized by a bank slope of $<40^{\circ}$ with sparse vegetation cover and high water depth. These areas extend over very small areas (a few meters) but offer excellent foraging ground. Anoop and Hussain (2004) observed that smooth-coated otters preferred low sloping banks ($<5^{\circ}$) with thick vegetation cover and shallow water in Periyar Tiger Reserve. Kruuk (1995) identified that minimizing the energetic expenditure of foraging is most desirable for otters to sustain themselves (optimal foraging), and therefore areas that offer the most dependable and easy food resources are preferred. In the River Moyar, the otters avoided narrow rocky stretches with deep slopes, where the physical constraints of the river led to less food availability and hampered their hunting ability. In the Moyar River, confluences of tributaries were favored by otters. The depth, turbidity and high congregation of fish populations in such areas provide the otters with easy food at the cost of minimal energy (Pinho et al., 2018).

Mapping prey availability throughout the river is essential to study food selection by otters. We could not achieve this completely, however, we documented 16 species of fish consumed by otters in River Moyar (KN unpubl. data) and the relative abundance of these species in different parts of the river was obtained from 30 sampling plots.

Kruuk et al. (1989) reported that there was a strong positive association between dens and freshwater; indicating that habitat selection largely depended on the requirements of otters either for food, sprainting plots or freshwater similarly to coastal otters. The otters equally avoided areas with dense vegetation, which offered dry leaf litter cover or invisibility. The importance of vegetation cover has however, been suggested previously for smooth-coated otters by Ruiz-Olmo and Consalbez (1997), Hussain and Choudhury (1995, 1997), for spotted-necked otters (*Lutra maculicollis*), for Cape clawless otters (*Aonyx capensis*) by Procter (1963), Rowe-Rowe (1992), and for the Eurasian otter (*Lutra lutra*) by Macdonald and Mason (1983). Kruuk and Goudswaard (1990), while investigating the reasons for the declining number of otters in Lake Victoria, Africa, described the virtual absence of otters from a section of the lake where the bank-side vegetation was poor.

The availability of temporary dens and resting plots is an important aspect of river otter habitat (Anoop and Hussain, 2004; Brown and Kodric-Brown, 1977). River otters select these plots according to availability and convenience, although spraint plots that provide protection and seclusion are preferred (Melquist and Hornocker, 1983). This was contrary to the observation in the Moyar, where open areas devoid of vegetation were favoured, and suggests that less vegetation cover on the bank could be important to Smooth-coated otters.

Easy access to the holts was also important and otters seemed to avoid longer trips on land, possibly to reduce their chances of encountering dholes (*Cuan alpinus*), leopards (*Panthera pardus*) and tigers (*Panthera tigris*), which were frequently spotted on the River Moyar. The selection of a sandy substrate for grooming could be because it is drier, thus absorbs moisture faster. Otters showed fidelity for grooming and spraint plots, but some plots were used only once or in one season only. Several authors (e.g. Kruuk et al., 1986; Macdonald and Mason, 1983; Hussain and Choudhury, 1997) have reported plot fidelity by other otter species. These plots are re-marked frequently generation after generation (Erlinge, 1967; Kruuk et al., 1986; Macdonald and Mason, 1983; Hussain and Choudhury, 1997). A similar observation was made during this study where grooming and sprainting plots were almost always revisited by otters. It was noted that during heavy rains certain plots got submerged, but once the waters receded, otters again used these plots. Any unrestricted disposal of dam water and rain could increase the water level of Moyar and has the potential to submerge all the traditional basking and grooming plots of the otters. This might result in them spending more time on land in search of new plots, which could pose an additional threat from terrestrial predators.

Human disturbance, in terms of fishing activities, agricultural runoff mixing and presence of anthropogenic activities also often affects otters (Brown and Kodric-Brown, 1977; Hussain and Choudhury, 1997). In Europe and North America, human disturbance may limit the otter populations (Dubuc et al, 1990; Beja, 1992; Newman and Griffin, 1994). This did not; however, seem to affect the otters in the Moyar. Instead, a tolerable association between otters and humans was observed, but during winter they avoided anthropogenic pressures due to heavy anthropogenic activities.

CONSERVATION IMPLICATIONS

The present study identifies key habitats for otter conservation, and the resultant predictive models have considerable practical application to future exercises, such as implementing conservation actions or population enhancement programmes within the Western Ghats regions. This work may also apply elsewhere in Asia. Our models can be used to predict other areas currently occupied by otters that may be suitable for future research. However, extending the models to a dynamic form could distinguish between other areas that the otters could colonize naturally, and those that they would be unlikely to reach. Smooth-coated otters are important components of aquatic ecosystems and the information presented here should improve humanity's ability to conserve them.

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RÉSUMÉ

ÉTUDE DE LA PRÉSENCE ET MODÉLISATION DE L'UTILISATION DES RESSOURCES DES LOUTRES À PELAGE LISSE *Lutrogale perspicillata* GEOFFROY (CARNIVORES, MUSTÉLIDÉS) LE LONG DE LA RIVIÈRE MOYAR DANS LE « HOTSPOT » DE LA BIODIVERSITÉ DES GHATS OCCIDENTALES

Comprendre les facteurs affectant la présence et les besoins en matière d'habitat des espèces menacées est fondamental pour leur protection. Les modèles d'occurrence et d'utilisation des ressources par la loutre à pelage lisse, vulnérable, ont été examinés entre 2015 et 2017 par échantillonnage des épreintes de loutres, des pistes, des tanières et des sites de toilettage le long de la rivière Moyar dans le « Hotspot » de la biodiversité des Ghats occidentaux en Inde. Un modèle basé sur l'occurrence a été utilisé pour déterminer l'influence des co-variables environnementales sur la détectabilité de la loutre. Des informations sur les paramètres environnementaux ont été enregistrées, tous les 400 mètres, le long des berges durant les saisons d'après mousson, d'hiver et d'été. La présence de loutres à pelage lisse était élevée avant l'été, mais a considérablement diminué après la mousson lorsque l'élévation du niveau d'eau réduit la détectabilité des loutres en éliminant les indices de présence. L'occurrence des loutres et les modèles d'utilisation des ressources ont été influencés par le substrat de la rivière, les caractéristiques de l'habitat et des berges, et les différents milieux forestiers. Les loutres préfèrent des rivières plus larges, mais évitent les zones rocheuses avec une faible profondeur d'eau. Les modèles d'utilisation des ressources ont été déterminés par les caractéristiques de l'habitat et les perturbations au cours des trois saisons. Diverses formes de perturbations ont nui à la présence de la loutre. La restauration des habitats dégradés améliore les perspectives de conservation des loutres à long terme. Les plans régionaux de conservation de la loutre doivent être spécifiques à l'espèce pour aider au maintien de l'équilibre écologique de l'écosystème rivière Moyar.

RESUMEN

EVALUACIÓN DE LA OCURRENCIA Y PATRÓN DE USO DE RECURSOS DE LA NUTRIA LISA *Lutrogale perspicillata* GEOFROY (CARNIVORA, MUSTELIDAE) EN EL RÍO MOYAR, HOTSPOT DE BIODIVERSIDAD DE LOS GHATS OCCIDENTALES

Entender los factores que afectan la presencia y los requerimientos de hábitat de las especies amenazadas, es fundamental para su conservación. Examinamos los patrones de ocurrencia y de uso de recursos por parte de la nutria lisa, muestreando el Río Moyar en el hotspot de biodiversidad de los Ghats Occidentales, India, entre 2015 y 2017, en busca de fecas, huellas, madrigueras y sitios de acicalamiento. Utilizamos un marco basado en la ocurrencia, para determinar la influencia de las covariables ambientales en la detectabilidad de las nutrias. La información sobre los parámetros ambientales fue registrada cada 400 metros a lo largo de las barrancas del río en las estaciones post-monzones, invierno, y verano. La ocurrencia de nutria lisa fue alta antes del verano pero disminuyó drásticamente después de los monzones, cuando los niveles aumentados de agua reducen la detectabilidad de las nutrias lavando los signos de su presencia. Los patrones de ocurrencia y uso de de recursos por las nutrias estuvieron influenciados por el sustrato del río, las características del hábitat, los rasgos de la barranca del río y los tipos forestales. Las nutrias prefieren mayor ancho del río, pero evitaron las áreas rocosas con agua poco profunda. Los patrones de uso de recursos estuvieron determinados por los rasgos del hábitat y los disturbios, en todas las estaciones. Varias formas de disturbio afectaron adversamente la ocurrencia de nutrias. La restauración de hábitats degradados es necesaria para mejorar las perspectivas de conservación de largo plazo de las nutrias. Se necesita que los planes regionales de conservación de nutrias sean especie-específicos, para ayudar a mantener el balance ecológico en el ecosistema del Río Moyar.

OSG MEMBER NEWS

Since the last issue, we have welcomed 7 new members to the OSG: you can read more about them on the Members-Only pages.

Mattia Branchesi, Italy: I have worked with sharks and otters in an aquarium for ten years. I am currently involved with a group of three female otters (Aonyx cinereus), training them for veterinary purposes. I have both attended and spoken about otters at a number of conferences and workshops.

Stacy Cotey, United States: I am working with North American River Otter (Lontra canadensis) in the Upper Peninsula of Michigan in the United States, including identifying individual otters from footprints in the snow, development of a resource selection function for otter habitat selection, evaluating connectivity of the landscape for otter populations, and determining the prevalence of Toxoplasma gondii in the otter population.

Lyn Fisk. United Kingdom: I manage The UK Wild Otter Trust rehabilitation Centre which is on my land - design, construction and maintenance of the otter enclosures, ordering and sourcing materials, feeding the cubs (currently we have 10 cubs here), feeding the resident Eurasian otters (we have 2), monitoring and introducing young cubs for possible pairings for rehab.

Nathalie Foerster, Brazil: I have been working with Giant Otters in Brazil for three years, and I'm also a member of the Giant Otter Project, coordinated by Dr. Caroline Leuchtenberger (https://giantotterproject.com/).

Frederick Kistner, Germany: I am a member of the Wildtrack group and have been working with (and especially tracking) Eurasian Otters (Lutra lutra) for more than 7 years, in several countries. I am currently working on Wildtracks' Footprint Identification Technology (FIT) application, using AI to classify otter footprints, and learn to predict features such as sex and age from otter tracks.

Stefan Ralević, Montenegro: I am currently surveying Montenegro for signs of otters; the last survey was incomplete and conducted 25 years ago. I also plan to work on otter diet and compare the north and south (Mediterranean coastal) part of Montenegro. Together with my colleagues, we have founded NGO Wildlife Montenegro which is the only mammal-focused NGO in the country.

Ilya Schegolev, Russia: Originally trained as a psychologist, and now a prfessional photographer, I participate in environmental protection activities aimed at drawing attention to threatened species of flora and fauna, as well as to the preservation of their biodiversity and habitats, including the European otter (Lutra lutra), living in the North-West of Russia. I alsotake part in the creation and development of otter education pages in Russian on Facebook, Instagram and Vkontakte