NOTE FROM THE EDITOR

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Dear Friends, Colleagues and Otter Enthusiasts!

It has become winter in the northern hemisphere and we start 2020 with the 1st issue of our IUCN OSG Bulletin of this year. The issue will be a full issue with the usual page numbers and it is in fact already "full". The idea is to close this issue as soon as possible as we do have already a compilation of manuscripts for the second issue of 2020. Many good reasons to regularly come back to our website.

In addition to the two regular issues in 2019 we also started the special issue of the IUCN Otter Specialist Group Bulletin 36A and information was send out to all participants. Bosco Chan, Nicole Duplaix, Syed Ainul Hussain and N. Sivasothi serve as guest editors. Manuscripts are continuously welcome and will go online as soon as they are reviewed, revised and finally accepted.

We also have two updates of the bibliographic issues of which one is already online. My sincere thanks to Victor Camp for again providing updates which for sure are of help for many of us working with the respective species.

On a personal note I allow myself to mention that it was in October 25 years ago that I was responsible for the first time for an issue of the IUCN OSG Bulletin.

My sincere thanks to Lesley. Lesley - without your never-ending efforts and time spent in your weekend there would be no way to deal with the publication of the increasing number of manuscripts.

A R T I C L E

ANALYSIS OF THE FOOD-WEB OF A POPULATION OF SMOOTH-COATED OTTERS *Lutrogale perspicillata* (MAMMALIA: MUSTELIDAE) IN A SALINE LITTORAL MANGROVE HABITAT

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Abstract: Aquaculture expansion, human-population pressure and retaliatory killing are threatening the smooth-coated otter (*Lutrogale perspicillata*) in mangrove habitats in Peninsular Malaysia. Our aim was to determine the diet of the smooth-coated otter (SCO) in a mangrove habitat, their feeding strategy and develop a food-web to inform the conservation of this species. We conducted spraint analysis and interviews with locals to identify the diet of SCO in the mangroves. We collected 91 spraints and identified 16 food items from six different taxa; fish, crab, shrimp, snake, barnacle and bivalve. Score bulk estimate and frequency of occurrence of prey were used to compare the importance of different taxa in the diet and this along with gut analysis of fish in the area were used to build a food-web. We found no dominate taxa but seasonal differences in their diet. SCO specialized on fish, crab and snake with fish comprising 44% and crab 43% of the diet. Fish occurred more frequently in the diet in the wet season and crab in the dry season. We conducted 25 interviews to determine tolerance of residents to SCO and to obtain feeding observations of them; no hunting was reported but SCO were disliked and harassed by fishermen and aquaculture farmers who saw them as competing for fish. The seasonal feeding strategy of SCO in mangrove habitat may have a greater effect on structuring the community than if their diet was dominated by fish. Conservation efforts need to focus on preventing future loss of mangroves; this may also reduce conflict between aquaculture farmers and otters.

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Keywords: carnivore, piscivore, feeding strategy, trophic cascade, apex predator

INTRODUCTION

The smooth-coated otter (SCO) *Lutrogale perspicillata* Gray 1865 (syn. *Lutra perspicillata* I. Geoffroy Saint-Hilaire, 1826) is the most common of the four species of otter found in Malaysia (Sivasothi and Nor 1994; Abdul-Patah et al., 2014; Rosli et al., 2015) but is under threat from anthropogenic activities involving land clearing and agricultural and residential development (Fig. 1). They are semi-aquatic, social-carnivores, hunting in small family groups (Helvoort et al., 1996) and are recognized as apex predators strongly influencing the structure of the food-web in habitats where they occur (Khan, 2015). Their presence in an environment can indicate its health as they are sensitive to aquatic pollution and degradation of the surrounding terrestrial habitat (Fournier-Chambrillon et al., 2004; Lemarchand et al., 2010, 2011). As a top predator, and being semi-aquatic, their disappearance from an ecosystem has a cascading effect on recruitment at different trophic levels in both the aquatic and terrestrial ecosystems leading to biodiversity loss, trophic skewing and decline in ecosystem functioning (Terborgh et al., 2001; Duffy, 2003; Sergio et

al., 2008; Reynolds and Bruno, 2012). In Southeast Asia, SCO habitats are threatened predominantly by anthropogenic activities, and mangrove ecosystems in particular are under threat from shrimp farms, tourism development, residential expansion and river pollution (Hamzah et al., 2009; Fulazzaky et al., 2010). Along the west coast of Peninsular Malaysia, where the largest expanse of mangroves exists, the habitat of the SCO is also threatened by loss of habitat due to palm oil expansion, poultry farms, and municipal and industrial waste water (Fulazzaky et al., 2010).

There are two recognized groups of otters in the world based on their trophic specialisation (Timm-Davis *et al*. 2015). They are either mouth-oriented and primarily consume fish or hand-oriented invertebrate consumers. SCO are a mouth-oriented feeder and feed predominately on fish with minor supplements of a variety of prey including snakes, rats and birds (Khan et al., 2010; Hussain, 2013; Abdul-Patah et al., 2014; Timm-Davis et al., 2015).

Although listed as Vulnerable (IUCN 3.1) and in CITES (Appendix 2) (de Silva et al., 2015), the SCO continues to be poached for its pelt, as well as captured in the wild for sale as demand increases for young otters in the pet trade (Gomez et al., 2017). There is also increasing human-otter conflict especially with increasing fisheries and aquaculture activities throughout Southeast Asia as they compete for fish and shrimp (Naderi et al., 2017**)**. In Malaysia, the SCO has total or complete protection under the Wildlife Conservation Act 2010. Despite this, the SCO has the status of 'local conservation concern' due to threats of habitat loss, water pollution and retaliatory killing (Abdul-Patah et al., 2014).

In this study we identified the diet of the SCO in mangrove habitat from spraint and responses from interviews with residents and used this information to develop a food-web. The aims of this study were to determine a) the diversity of prey in the diet of the SCO in mangroves; b) if there was a seasonal influence on the type of prey consumed, c) to construct a food-web of the SCO that live in the mangroves, and d) determine if there is conflict between members of the local community and otters where the habitat of humans and otters overlap.

Figure 1. Smooth-coated otter in a muddy channel at Kuala Selangor Nature Park, Selangor, Malaysia. (Photo G.W. Wilson)

MATERIALS AND METHODS

Study area

This study was conducted in the mangrove forests of Kuala Selangor (3° 20' 23.917" N, 101° 14' 14.546"E) located on the west coast of Selangor, Malaysia (Fig. 2). The coastal stretch of Selangor comprises 800,000 ha of land, of which 15,000 ha (1.6%) is covered by mangrove (Hamzah et al., 2009). The study was conducted at the Kuala Selangor Nature Park (KSNP), located in the estuary of the Selangor River; the river is highly polluted (Fulazzaky et al., 2010). The mangrove forest of KSNP is confined by a reclamation bund (dirt embankment) and channel built to drain the landward mangroves. The drained area has since modified through succession into secondary forest. A shallow man-made lake was also constructed between the secondary forest and the mangrove forest and is frequented by SCO (Davison et al., 1989). Abiotic measurements of the channels in KSNP during this study indicated they were highly polluted (mean ± SE from 30 samples taken over 8 months: turbidity 50.29 ± 6.99 cm, conductivity 8.27 ± 1.30 ms, dissolved oxygen 4.67 ± 1.01 ppm, pH 4.96 ± 0.31; water temperature 30 ± 0.6 °C. Average depth of the channels was 76.33 ± 6.99 cm).

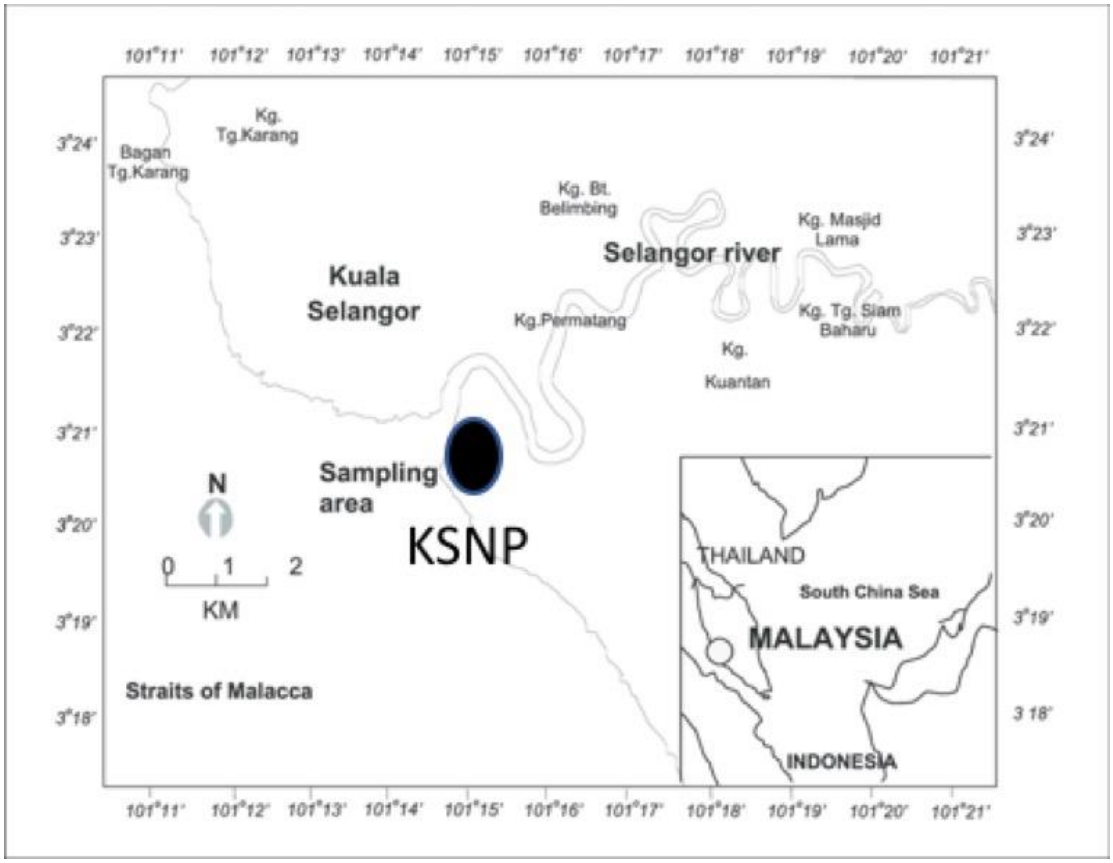

Figure 2. Sampling area (●) within Kuala Selangor Nature Park (KSNP) at the entrance to the Selangor River, Selangor, Malaysia

According to the Malaysian Meteorological Department (2016), the months of August to September 2015 and February to March 2016 were particularly dry in Selangor, with average rainfall of less than 200 mm. They are referred to in this study as the Dry Season. The months of October 2015 to January 2016 had heavy rainfall (more than 400 mm), hence were considered the Wet Season.

Spraint processing

Spraint was collected opportunistically between August 2015 and the end of March 2016, along the bund wall at KSNP. Sampling was done at dawn and dusk for three days each month, except in December and January, were samples were collected over six days in both months. Only fresh spraint was collected, primarily from latrine sites where otters crossed the bund wall at dawn and/or dusk. Fresh spraint was readily identified by its wet appearance, fishy smell and for some, the presence of a green or brown mucous called anal jelly; it also consisted of predominantly fish bones and scales. Individual spraints were collected using a clean spatula, sealed in plastic bags and stored on ice for transfer to a -20 °C freezer until being processed in the laboratory. Spraint were processed by individually washing them under running water and trapping undigested components on a 1 mm sieve. Prey remnants such as bones, scales and shells were oven-dried at 60 °C for 20 - 30 minutes, weighed to obtain the total dry weight, then separated into prey classes and weighed. Remnants were examined using a Zeiss Stemi DV4 stereo microscope. Prey items in trace amounts were not included in the analysis in order to eliminate the chances of contamination, as some of the spraint were excreted on top of older spraint. The number of individuals of prey was estimated according to the observable set of otoliths, eye lens, claws, limbs, rostrum and uropods. Otoliths, backbones and scales of fish from the spraint were taken and compared with a reference sample of mature fish bought at the local fish market at Pasir Penambang, Kuala Selangor. Crabs were identified according to the rostrum and limbs and compared to a reference collection from KSNP.

For the fish reference collection, scales were taken from five different parts of the body: head, dorsum, below pectoral fin, abdomen and tail. This was to ensure variations of the scale between each body part were included in the reference sample. The fish were then dissected and gutted and the gut contents were examined under the light microscope. The remaining fish were boiled and the bones were kept in 70% ethanol. The fish were identified using either scales or otoliths. The occurrence of catfish was characterised with the presence of the spine and undigested skin. A photograph of each scale was taken to facilitate the identification of the scales from spraints.

Local interviews

Semi-structured interviews, involving the local fishermen, aquaculture farmers and residents in Kuala Selangor, were conducted to question them about the diet of the SCO and any conflict between them and otters (Appendix 1). Only locals that could correctly identify images of the SCO and had seen otters in the region were included in the survey. Qualitative data was analysed using content analysis where we grouped responses into categories and report frequency. Interviews were conducted in both English and Bahasa Melayu by Namaskari.

Analysis

Chi-square tests were used to test for differences in spraint collection between months and seasons using IBM SPSS Statistics Version 22. All testing was done with α=0.05 significance level. Score bulk estimates (SBE) and frequency of occurrence (FO) was used to determine the contribution of different food items to the diet (Fonseca et al., 2008).

Food-web metrics

A food-web was constructed using results of the prey analyses, interviews and calculations of the number of links (L), linkage density ($LD = \frac{L}{S}$, where S = species richness), connectance ($C = \frac{2L}{S(S-1)}$) and degree of omnivory ($OD = \frac{O}{S} \times 100\%$, where O =

number of omnivores). Formula for food metrics are according to Banasek-Richter et al. (2009). Higher trophic levels were built using prey items identified in the spraints, and observations of respondents we interviewed. Fish were grouped according to whether they were herbivores, omnivores, or carnivores. Lower trophic levels were constructed from gut analysis of fish from the local market in Kuala Selangor and observations of organisms in the mudflats and lake at KSNP.

RESULTS

Number of SCO observations and spraint samples collected

SCOs were sighted 11 times at KSNP between August 2015 and March 2016. No sightings of other otter species were made or reported during the study period so it is reasonable to assume the spraint collected were from SCO. A total of 91 fresh otter spraints were collected between August 2015 and March 2016. Spraint was found during 22 of the 32 sampling days; there was a 68.8% success rate of finding at least one fresh spraint per day. The average number of spraint collected in the wet season (3.00±0.69 S.E.) and the dry (2.54±1.10 S.E.) was not significantly different (χ^2_1=1.282, P=0.258).

Dietary composition

Six different prey taxa were found in the samples: fish, crab, shrimp, snake, bivalve and barnacle (Table 1). The most common fish was catfish *Ariidae* sp., followed by tilapia *Oreochromis* sp. The scales of five unknown species were found in the samples, one on six occasions. In three samples, neither scales nor otoliths were found. Crabs were found in 38 spraint and were mostly of sesarmid crabs; they occurred more than twice as frequently as other food items (Table 1). All the shrimp were penaeid shrimps. The snakes, identified from scales of undigested skin, were all mangrove pit viper *Trimeresurus purpureomaculatus* (S. Wong, personal communication February 2016).

SBE revealed that the most consumed prey taxa were fish (44%) and crabs (42.68%), followed by shrimp (6.77%) and snake (5.92%), with negligible percentages of bivalve and barnacle. The feeding strategy of the SCO suggest they are specialising on crab, fish and snake whereas shrimp, bivalve and barnacle were taken opportunistically; no food taxa were dominant in the diet (Fig. 3). Niche width (high between-phenotype vs high within-phenotype contribution) indicated crab, fish and snake were high between-phenotype whereas shrimp, bivalve and barnacle were high within phenotype. Levin's niche breadth (NB) index calculated for the SCO in this study was 3.53 and the standardised NB value was 0.51 indicating there is no dominate use of a single resource and resources are not used equally.

The average daily prey diversity was highest in November (mean=1.78, S.E.=0.11) and lowest in February (mean=1.00, S.E.=0). Five different types of prey were found in some spraint in November but only one type of prey (crab) in February. There was no significant difference in the number of prey types between the months (χ^2_7=10.645, P=0.155). However, there was a significant difference in the average number of prey types found between the seasons (χ^2_1=5.990, P<0.014) with a greater number of different types of prey in the spraint in the wet season (mean±S.E.=1.62±0.05), than the dry season (mean±S.E.=1.26±0.07). Fish occurrence in the spraint was much higher in the wet season than the dry whereas crabs had a higher frequency of occurrence in the dry than the wet (Fig. 4). Fish was found in high abundance throughout the sampling period except February and March; no fish were found in the diet in February, while its highest abundance was in November (mean±S.E.=0.87±0.11). Crab was found in all samples during February and March.

Table 1. Prey taxa found in the scats of the smooth-coated otter and the number of occurrence for each prey type.

Prey taxa	Common name	Scientific name	Number of occurrences
Fish	Catfish	*Ariidae* sp.	14
	Tilapia	*Oreochromis* sp.	13
	Blue-spot mullet	*Moolgarda seheli*	9
	Mudskipper	*Oxudercinae* sp.	5
	Tiger-toothed croaker	*Otolithes ruber (Syn. Pennahia anea)*	2
	Unknown sp. 1		6
	Unknown sp. 2		1
	Unknown sp. 3		1
	Unknown sp. 4		1
	Unknown sp. 5		1
Crab	Sesarmid crab	*Sesarmidae* sp.	32
	Fiddler crab	*Uca* sp.	6
Shrimp	Penaeid shrimp	Penaeidae sp.	19
Snake	Mangrove pit viper	*Trimeresurus purpureomaculatus*	8
Bivalve	Mussel	*Mytilidae* sp.	6
Barnacle	Barnacle	*Cirripedia* sp.	5

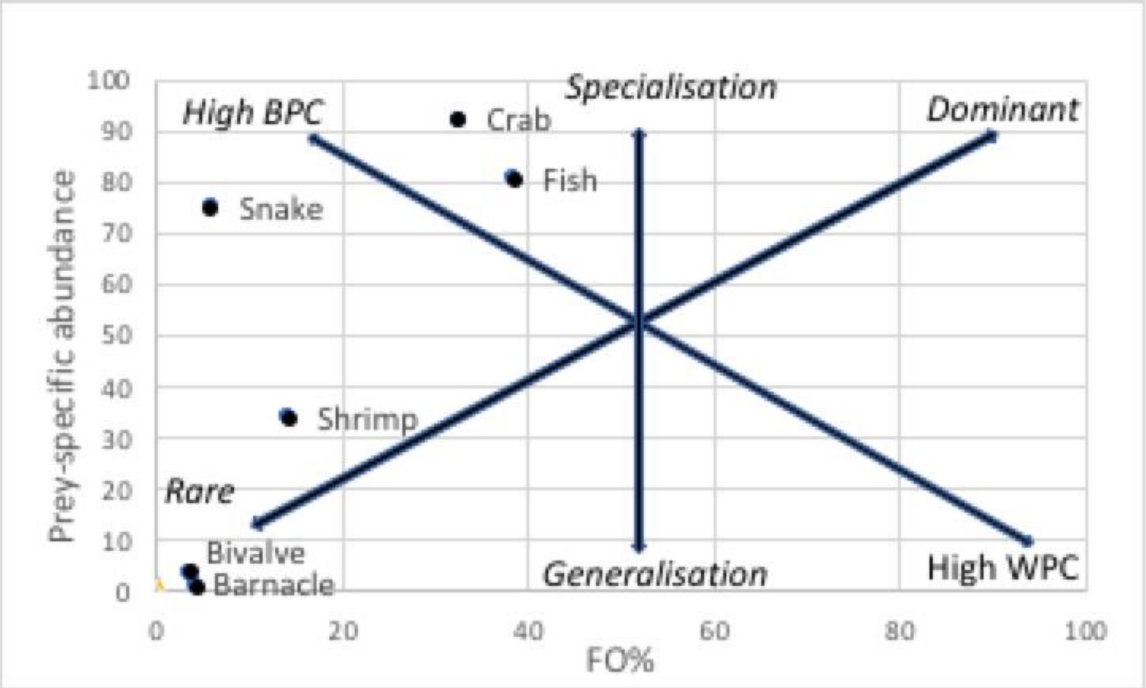

Figure 3. Relationship between Frequency of Occurrence (FO) and Prey-specific abundance indicating the feeding strategy, feeding importance and niche variation of the smooth-coated otter. Explanatory axes for foraging patterns follow Amundsen et al. (1996), modified from Costello (1990). The vertical axis defines the predator feeding strategy (specialist vs generalist) and the two diagonal axes represent the importance of prey (dominant vs rare) and the contribution to the niche width (high between-phenotype (BPC) vs high within-phenotype (WPC) contribution).

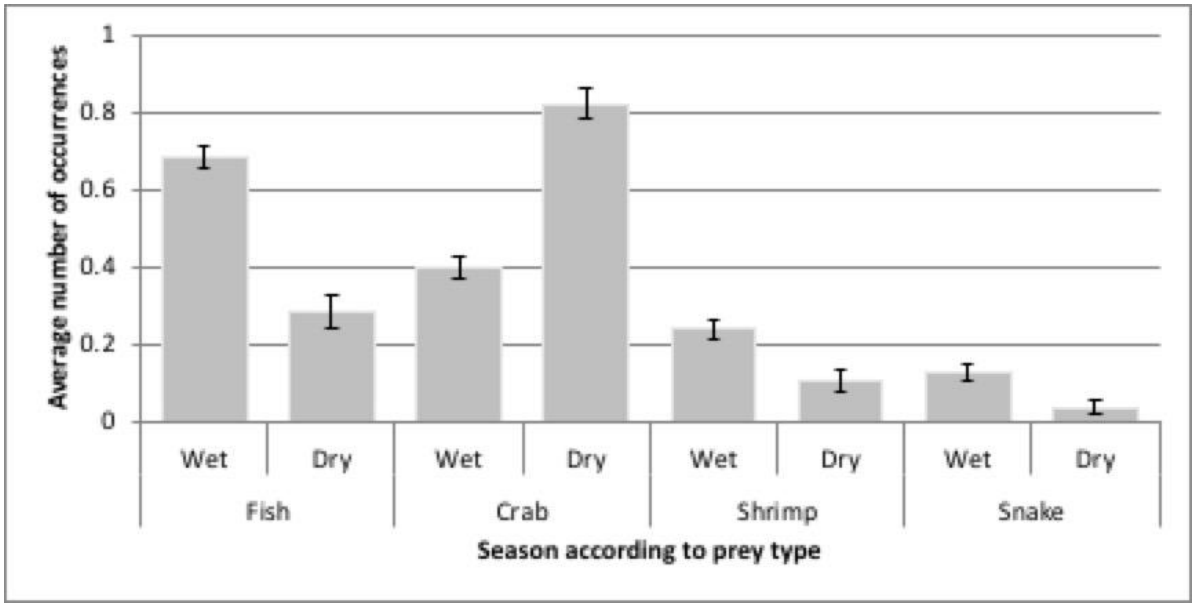

Figure 4. Average number of occurrences of each prey in spraint in each season (± 1 S.E.).

A total of 25 respondents were interviewed; they included 15 fishermen, six rice farmers and four aquaculture farmers, all from the Kuala Selangor region. With the exception of the aquaculture farmers, all of the respondents had seen otters in the area (i.e. channels, fishing ponds, Selangor River, paddy fields). None of the aquaculture farmers have seen otters in their ponds. Nine of the respondents, including all four aquaculture farmers, stated they didn't like otters and they chased them when they were encountered; the rest were indifferent and ignored the otters when they sighted them. Most respondents mentioned that they have observed otters eating fish, but some also reported otters eating chicken eggs, chickens *Gallus gallus domesticus*, with a single sighting of an otter eating a cobra *(unknown species)*.

Food-web metrics calculated from the food-web developed in this study (Fig. 5) included 20 species, 58 links, connectance 0.305, linkage density 2.9 and degree of omnivory 10.0%.

DISCUSSION

In this study the diversity of prey in the diet of SCO in the mangroves was relatively high, in common with other studies of SCO in more diverse habitats (Anoop and Hussain, 2005; Abdul-Patah et al., 2014; Theng et al., 2016). However, in contrast to other studies where fish comprised 69-100% of the diet of SCO (Tiler et al., 1989, Foster-Turley, 1992 (Perak, Malaysia), Kruuk et al., 1994 (Thailand); Melisch et al., 1996 (Java, Indonesia), Hussain and Choudhury, 1998 (India); Anoop and Hussain 2005 (India); Abdul-Patah et al., 2014; Theng and Sivasothi, 2016 (Singapore)) we found it did not dominate the diet of SCO in our mangrove community. Theng and Sivasothi (2016) report high levels of fish in the diet of SCO (92% SBE) when they combined their sites but when considering their mangrove site in isolation the contribution of fish in the diet was greatly reduced (65.4%). Our results similarly support the lower contribution of fish in the diet of SCO in the mangroves.

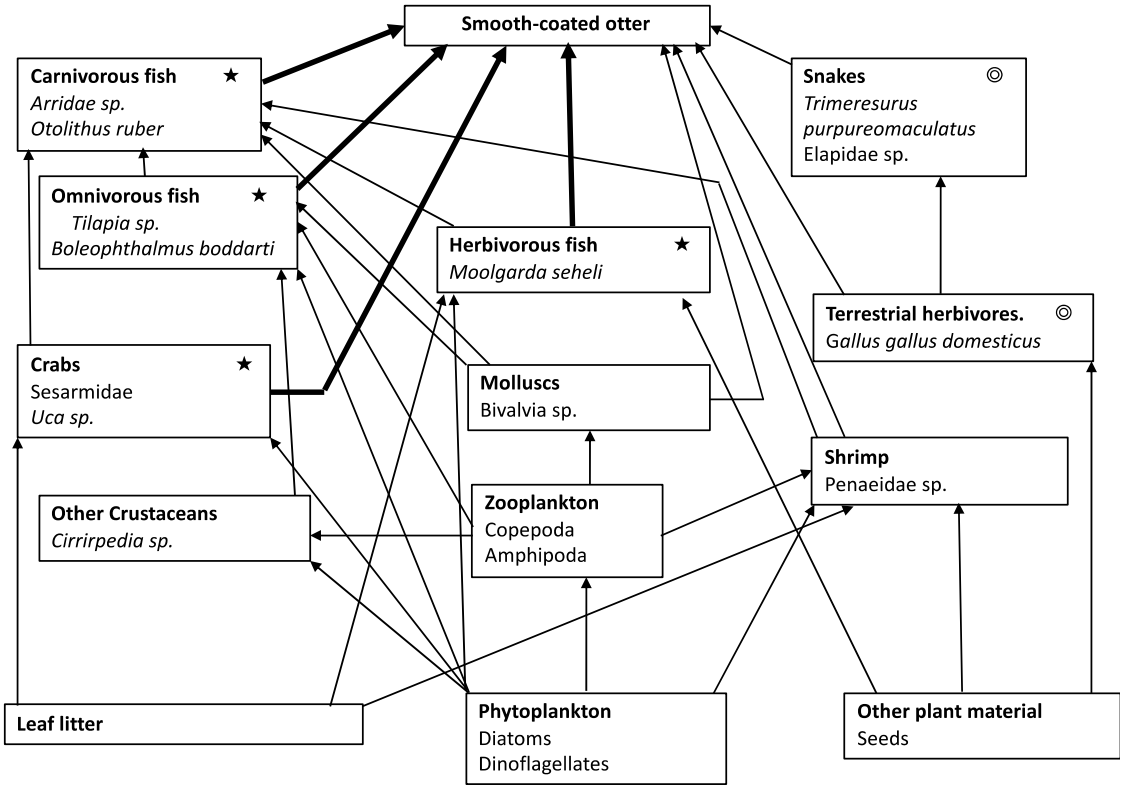

Figure 5. Food web created from the spraint of the smooth-coated otter, their prey in mangrove habitat, material in the gut of a fish reference collection and observations by interviewees. Prey marked by ★ and bold arrow were consumed in large numbers, and prey marked ◎ were observed being eatten by smooth-coated otters by interviewees.

This study also found a different mix of taxa being consumed than in other studies with snake, bivalve and barnacles in the spraint but no amphibians, birds or small mammals (Table 2). This difference may reflect a difference in the availability of prey for a coastal population compared to terrestrial populations that were included in the other studies. However, barnacles and bivalves were rare in the spraint and possibly bycatch attached to other prey or scooped up along with catfish which are bottom feeders. No plant material was found in the diet in common with other studies of SCO, confirming they are obligate carnivores. The occurrence of a high percentage of crab in the diet of SCO of this study was in marked contrast to other studies that report the Frequency of occurrence (FO%) and Score Bulk Estimate (SBE%,) (Table 2). This may reflect the prey available in a mangrove habitat and the hunting conditions in the turbid water in the local system.

Levins index of the prey niche-breadth showed no dominant single source of prey being consumed, supporting the findings of Fig. 3 (FO plotted against Prey-specific abundance addressing the feeding strategy). In contrast to other studies our finding suggest the SCO were specializing on fish, crab and snake but none were dominant in the diet (Fig. 3; Table 2). Only one species of snake was identified in the spraint in this study, that was the mangrove pit viper, and may have been an opportunistic event. However, an interviewee also reported sighting a SCO consuming a snake, suggesting that snake may be important in the diet of the otter but not as readily available as fish and crabs in the mangrove habitat; this prey taxa had a lower frequency of occurrence and SBE than fish and crabs.

Table 2. Frequency of occurrence (FO%) and Score Bulk Estimate (SBE%,) for smooth-coated otters from Anoop and Hussain (2005; India), Abdul-Patah et al., (2014; Malaysia) and Theng and Sivasothi (2016; Singapore) compared with results from this study.

Prey	Frequency of occurrence (%) and Score Bulk Estimate (%)					
	This study		Abdul-Patah et al., 2005	Anoop and Hussain, 2005	Theng and and Sivasothi, 2016	
	FO	SBE	FO	SBE	SBE	
Fish	38.64	44.00	72.40	96.02	92.0	
Crab	32.58	42.68	1.00	1.07	-	
Shrimp	14.39	6.77	15.00	-	8.0	
Snake	6.02	. 5.92	-	-	-	
Barnacle	3.76	. 0.33	-	-	-	
Bivalve	4.51	0.31	-	-	-	
Amphibians	-		3.00	1.08	-	
Birds	-		1.00	1.07	-	
Insects	-		1.00	0.76	-	
Mammals	-		7.50	-	-	

In this study, tilapia, an introduced species of fish to Malaysia, comprised a significant component of the diet of SCO. Consumption of this fish species by the SCO may contribute to its control but may also lead to competition with local residents who also consume and sell this fish species in the market. Anoop and Hussein (2005) also found large numbers of tilapia being consumed by SCO in Kerala, India and similarly considered SCO may control the expansion of this species.

Sesarmidae crabs were found to occur more frequently, 32 of the 91 spraints, than any other food item consumed; they were particularly important in the diet in the dry season when the SCO appeared to be specialising on them. In the dry season fish appeared less frequently in their diet and may have been less readily available in the channels and estuary due to higher temperatures affecting oxygen levels, and lower precipitation affecting salinity, water depth and nutrient concentrations, and the migration of fish out of the area (Elliott et al., 2007; Gillanders et al., 2011; Sales et al., 2018). Sesarmidae crabs were numerous on the mudflats under the mangroves at low tide throughout the study and comprise one of the highest biomasses of mangrove crabs in Malaysia (Ashton, 2002). These crabs not only make an important contribution to the diet of the SCO but also the mangrove ecosystem. In contrast, mudskippers, that were also prevalent across the mangrove flats and man-made lake at KSNP throughout the study, were not consumed as frequently as may be expected by their abundance, especially in the dry season when fish appeared less frequently in the spraint. SCO were not observed trying to excavate mudskippers from burrows in contrast to observations of this by the Asian Small-clawed otter (ASCO), *Aonyx cinereus* on mudflats in Bangladesh (Aziz, 2018). It may be that the ASCO that are hand-oriented invertebrate consumers are better at catching the mudskippers than the mouth-orientated SCO that are better adapted to underwater capture of prey (Timm-Davis et al., 2015).

Conflict between humans and SCOs in Malaysia was apparent from our interviews and observations of Foster-Turley (1992). However, there was no mention of the otters being hunted, killed or young taken for pets as has been reported in many localities across Asia

(Hon et al., 2010; Gomez et al., 2017). There were also no reports of otters caught in nets or fish traps as has been observed in India (Kanchanasaka, 2004 in Hon et al., 2010).

It is reasonable to assume the otters are eating more items than detected in this study and thus the food-web of the SCO produced here is considered a minimalist version of their diet in a mangrove ecosystem. Further behavioural and spraint observations and the use of faecal DNA analysis stable isotopes and biologgers (Deagle et al., 2005; Rosli et al., 2014; Jeanniard-du-Dot et al., 2017) are required to improve the food-web. The latter will assist in confirming the prey items and also identify digestible items. We attempted faecal DNA analysis in this study but the results were inconclusive; we failed to get bands which could be due to several reasons including the universal primer we selected and our lack of experience in analysing faecal DNA.

There are also few studies on the SCO in Malaysia (Ratnayeke et al., 2018) and only one on the feeding strategies of SCO (Helvoort et al., 1996) who observed a group of eight SCO's at KSNP in a coordinated feeding bout in the channel, highlighting a paucity of information on SCO.

Mangroves have been reported as an important habitat for SCO both in this study and others (Helvoort et al., 1996; Shariff, 1984 in Sivasothi and Nor, 1994; Theng and Sivasothi 2016) but are a declining resource in Malaysia where they are being destroyed in the process of land development (Hamzah et al., 2009). A recent analysis using Geographical Information Systems by Hamzah et al. (2009) of the distribution and extent of mangroves in the state of Selangor, where this study was conducted, found the mangrove habitat had decreased 'from 28,954.6 ha in 1989 to 19,456.1ha in 2007, a reduction of about 9,498.5ha or 32.8% with the average loss of some 527.7 ha per year.' This rate of change will affect the habitat available to and the movements of the SCO and is not sustainable for the mangrove community as a whole. As a semi-aquatic species SCO play an important role in external subsidies moving matter between habitats and their disappearance from the mangroves will also have implications for the health of neighbouring habitat (Bartels et al., 2012).

The main reason for the decline of mangroves identified by Hamzah *et al.* (2009) was urban, aquaculture and agriculture expansion that were also exacerbating the negative effect of tsunamis, El Niño and La Niña events. As most of these activities involve major enterprises and the government, it suggests that government agencies need to work together in managing mangroves and implementing the Permanent Forest Agreements (sustainable harvest) so no further net loss occurs.

CONCLUSION

We have shown that the diet of the SCO in a mangrove community differs from that in a terrestrial landscape; in the mangroves their diet was specialised on three taxa but no taxa dominated it. This difference in feeding strategy in the mangroves may have a greater effect on structuring the community than if the SCO focused its diet on fish as observed in other landscapes. The effect of SCO in structuring the mangrove community needs to be considered in the management of the mangrove habitat. We recommend policy development and implementation that involves the protection of the SCO, no further loss of mangroves, rehabilitation of degraded mangrove habitat and an educational program, targeting aquaculture farmers and local fishermen, that may reduce human-wildlife conflict. The latter needs to highlight the role of the SCO in the health of the mangrove community and the value of mangrove habitat in conservation.

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funding to support this research. We also thank Mr. Stephen Wong for identifying the mangrove pit viper. The authors declare no conflict of interest.

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RÉSUMÉ

ANALYSE DU RESEAU TROPHIQUE DES LOUTRES À PELAGE LISSE *Lutrogale perspicillata* (MAMMIFÈRES: MUSTÉLIDÉS) DANS UN HABITAT LITTORAL SALIN DE MANGROVE

L'expansion de l'aquaculture, la pression démographique et la mise à mort par représailles menacent la loutre à pelage lisse (*Lutrogale perspicillata*) dans les habitats de mangroves de la péninsule malésienne. Notre objectif était de déterminer le régime alimentaire de la loutre à pelage lisse (LPL) dans un habitat de type mangrove, sa stratégie d'alimentation et de développer un réseau trophique pour éclairer la conservation de cette espèce. Nous avons effectué une analyse des épreintes et des rencontres avec les habitants pour identifier le régime alimentaire des LPL dans les mangroves. Nous avons collecté 91 épreintes et identifié 16 aliments provenant de six taxons différents : poissons, crabes, crevettes, serpents, bernacles et bivalves. L'estimation globale par score et la fréquence d'apparition des proies ont été utilisées pour comparer l'importance des différents taxons dans le régime alimentaire. Ces analyses, associées à celle du tube digestif des poissons de la région, ont été utilisées pour créer un réseau trophique. Nous n'avons trouvé aucun taxon dominant, mais des différences saisonnières dans leur régime alimentaire. LPL était spécialisée dans le poisson, le crabe et le serpent, avec 44% de poisson et 43% de crabe. Le poisson était présent plus fréquemment dans l'alimentation pendant la saison des pluies et le crabe pendant la saison sèche. Nous avons mené 25 entretiens pour déterminer la tolérance des habitants vis-à-vis de la LPL et obtenir des observations sur l'alimentation de celle-ci. Aucune chasse n'a été signalée, cependant, les pêcheurs et les aquaculteurs, qui la considèrent comme une concurrente, se plaignaient de la LPL et la harcelaient. La stratégie d'alimentation saisonnière de la LPL dans les habitats de mangroves pourrait avoir un effet plus important sur la structuration de la communauté que si leur régime alimentaire était dominé par le poisson. Les efforts de conservation doivent être axés sur la prévention de la régression future des mangroves ; Cela pourrait également réduire les conflits entre les aquaculteurs et les loutres.

RESUMEN

ANÁLISIS DE LA RED ALIMENTARIA DE UNA POBLACIÓN DE NUTRIA LISA *Lutrogale perspicillata* (MAMMALIA: MUSTELIDAE) EN UN HÁBITAT DE MANGLAR LITORAL SALINO

La expansión de la acuicultura, la presión poblacional humana y la matanza retaliatoria, están amenazando a la nutria lisa (*Lutrogale perspicillata*) en los hábitats de manglar en Malasia Peninsular. Nuestro objetivo fue determinar la dieta de la nutria lisa (NL) en un hábitat de manglar, su estrategia alimentaria, y desarrollar una red alimentaria para ayudar con

información a la conservación de esta especie. Condujimos análisis de fecas y entrevistas con gente local, para identificar la dieta de la NL en los manglares. Colectamos 91 fecas e identificamos 16 items alimentarios de seis taxones diferentes; peces, cangrejos, camarones, serpientes, percebes y bivalvos. Usamos estimaciones de rankeo visual, y la frecuencia de ocurrencia de las presas, para comparar la importancia de los distintos taxa en la dieta; y ésto junto con el análisis de contenidos estomacales de peces del área, fue usado para construir una red alimentaria. No encontramos taxa dominantes, pero sí diferencias estacionales en la dieta. La NL se especializó en peces, cangrejos y serpientes, con los peces alcanzando 44% y los cangrejos 43% de la dieta. Los peces aparecieron más frecuentemente en la dieta en la estación húmeda, y los cangrejos en la estación seca. Condujimos 25 entrevistas para determinar la tolerancia de los residentes hacia la NL, y para obtener observaciones sobre alimentación; no se informó de cacería, pero la NL no está favorecida en la visión de los residentes, y es ahuyentada por los pescadores y los acuicultores, que la ven como compitiendo por los peces. La estrategia alimentaria estacional de la NL en el hábitat de manglar puede tener un mayor efecto en la estructuración de la comunidad que si la dieta estuviera dominada por peces. Los esfuerzos de conservación deben focalizarse en prevenir la futura pérdida de manglares; ésto también puede reducir el conflicto entre los acuicultores y las nutrias.

Appendix 1. Questionnaire used in semi-structured interviews

Personal details

Occupation: _____

Business- number of people involved: ___

Family- number of members: _____

Location: _____

Age group:

a) 18-25
b) 26-30
c) 31-35
d) 36-40
e) 41-45
f) 46-50
g) >50

Otter sightings

1. Do you know what an otter is?
   a. Yes b. No

2. Have you ever seen otters?
   a. Yes b. No

If yes, please describe the otter (size, colour)

_____

3. Where do you often see otters?
   a. Rice paddy
   b. Aquaculture ponds
   c. On river/channel banks
   d. In the channels/creeks
   e. Other _____

4. How often do you see otters?
   a. Every day
   b. A few times a week
   c. Once a week
   d. A few times a month
   e. Once a month
   f. A few times a year
   g. Once a year

5. How many individuals of otters do you normally see?
   a. One individual
   b. 2-5 individuals
   c. 6-10 individuals
   d. 10 or more individuals

Fishing

a) Do you fish?
   a. Yes b. No

b) How often do you go fishing?
   ___days per week ___hours per day

c) Where do you go fishing?
   _____

d) Do you fish as a recreational activity or as source of income?
   a. Recreational b. Source of income

e) Have you encountered any otters while fishing?
   a. Yes b. No

If yes, how often do you see otters while fishing?

a. Every day
b. A few times a week
c. Once a week
d. A few times a month
e. Once a month
f. A few times a year
g. Once a year

f) Do you see otters eating the same things you are catching?

a. Yes b. No

If yes, what are they eating?

_____

g) Have you ever seen otters getting caught in fishing nets?

a. Yes b. No

If yes, are they able to free themselves or do they get stuck?

a. They free themselves b. They get stuck

_____

h) Have you ever seen otters getting caught in fishing nets?

a. Yes b. No

If yes, are they able to free themselves or do they get stuck?

a. They free themselves b. They get stuck

Fish pond

1. Do you own any fish ponds?

a. Yes b. No

2. What type of animals are in the pond?

_____

3. How many animals do you have in the pond?

_____

4. Have you seen otters coming into the fish pond?

a. Yes b. No

5. Have you seen otters feeding on the animals in the fish pond?

a. Yes b. No

6. If yes, what were they eating?

_____

7. How often do you see otters coming to the pond?

a) Every day
b) A few times a week
c) Once a week
d) A few times a month
e) Once a month
f) A few times a year
g) Once a year

Perception of otters

1. How do you react if you see otters?

   _____

2. How do you react if you see otters feeding on the animals in the pond?

   _____

3. Do you capture/hunt otters?
   a. Yes
   b. No

If yes, what do you do with the otter?

_____

4. Do you know anyone who captures/hunts otters?

   a. Yes
   b. No

5. Do you like otters? Why or why not?
   a. Yes

   _____

   b. No

   _____

A R T I C L E

HOLT-BASED ACTIVITY PATTERNS OF SMOOTH-COATED OTTER (*Lutrogale perspicillata*) IN THE LOWER KINABATANGAN WILDLIFE SANCTUARY, SABAH, MALAYSIA

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ABSTRACT: Despite being one of the most biodiverse regions in the world, not much is known concerning the ecology of the otters on Borneo. We conducted a study to document the activity patterns of the smooth-coated otter, *Lutrogale perspicillata*, in increasingly disturbed and fragmented habitats in the Lower Kinabatangan Wildlife Sanctuary (LKWS), located in the Malaysian state of Sabah, northern Borneo. The aim was to gather ecological information for establishing baseline data and to understand better the otter behavior in this region of Sabah. We deployed camera traps at active otter holts, grooming and sprainting sites for 15 non-consecutive months and utilized the photographs to model the activity patterns of the otter using kernel's density estimate modeling. Results showed that *L. perspicillata* in the LKWS was mainly crepuscular, with otter activity mainly occurring during early morning (0600 h) and late afternoon (1600 h - 1800 h). Grooming activity peaked at 0600 h while sprainting activity peaked at both 0800 h and 1700 h. We suggest that activity patterns of *L. perspicillata* may be influenced by prey availability, human disturbance and environmental temperature.

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INTRODUCTION

A total of 379 species of mammals are known to be found in the island of Borneo (Phillips and Phillips, 2016), including four otter species; *Lutrogale perspicillata* (smooth otter), *Aonyx cinereus* (Asian small-clawed otter), *Lutra sumatrana* (hairy-nosed otter) and *Lutra lutra* (Eurasian otter). In Sabah, *L. perspicillata* and *A. cinereus* are commonly seen, however, no scientific studies have been conducted on otters in the Lower Kinabatangan Wildlife Sanctuary (LKWS). *L. sumatrana* was rediscovered in Sabah in 2010 and *L. lutra* was considered extinct in Borneo during the Borneo Carnivore Symposium in 2011. However, *L. lutra* was rediscovered and photographed in 2015.

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The LKWS is a forest corridor along the Kinabatangan River in Sabah and it is an area comprised of a mixture of primary and logged lowland dipterocarp forests surrounded mainly by oil palm plantations (Abram et al., 2014; Ancrenaz et al., 2004). Despite being surrounded by human-modified landscapes, the narrow strip of forest corridor remains an important habitat for flora and fauna including otter species. To date, there are two otter species documented in the examined reaches of the LKWS; *L. perspicillata* and *A. cinereus.*

There has been no published research into the activity patterns on *L. perspicillata* in Borneo. In other regions within their range, the species displays diurnal behavior (Hussain, 2013), although others have reported otters will become more nocturnal following increasing levels of human disturbances (Kruuk, 2006). Camera trapping has been widely used in wildlife surveys throughout the region and has been effective in detecting elusive species such as otters (Bernard et al., 2013; Evans et al., 2016; Matsubayashi et al., 2011; Samejima and Semiadi, 2012). In this study, camera traps were used to record the daily activity patterns of *L. perspicillata* at active holts, grooming and sprainting sites situated within the degraded landscape of LKWS. Understanding the daily activity pattern of this species provides a valuable ecological information of *L. perspicillata* within degraded landscape, which will become the baseline for conserving this species in Sabah. This baseline data can be used to protect and conserve otter habitat, as well as managing human-otter conflict in Sabah.

STUDY AREA

The LKWS is located on the east coast of Sabah, Malaysia Borneo (Figure 1), and comprises 27,000 ha of protected forest divided into 10 lots after being gazetted by the Sabah Wildlife Department in 2002 (Ancrenaz et al., 2004). The lowland dipterocarp forests in the Kinabatangan floodplain have undergone drastic human changes since the 1950s, particularly in the form of logging and agriculture, resulting in the extensive conversion of rainforest into oil palm (*Elaeis guineensis*) plantations (Abram et al., 2014; Ancrenaz et al., 2004). Despite the large amount of agriculture along the Kinabatangan River, a seemingly high diversity of Bornean species continues to persist within the floodplain (Abram et al., 2014; Evans et al., 2016). The mean annual rainfall of the region is 3,000 mm and average temperatures range from 21 - 34 °C.

METHODS

Camera trapping

A total of 40 kilometers of the Kinabatangan River (see Figure 2) were surveyed and two active otter holts, one grooming and one sprainting site were encountered. Reconyx HyperFire Professional Infrared camera traps (Models HD500 and PC800) in protective iron casings were deployed directly in front of the two active holts, an additional unit was placed at the holt grooming site, while one more was set up at the sprainting site (see Figure 2). The camera traps were set up for a period of 15 non-consecutive months (April 2016 - June 2017); monitoring was non-consecutive due to flooding events in the region, as cameras were removed to avoid damage. Camera traps took a series of three images at 1-second intervals when triggered, and during low lighting conditions, an infrared flash was used for successful and minimal stressful nocturnal imaging. Batteries and memory cards were changed and data were retrieved every 30 days

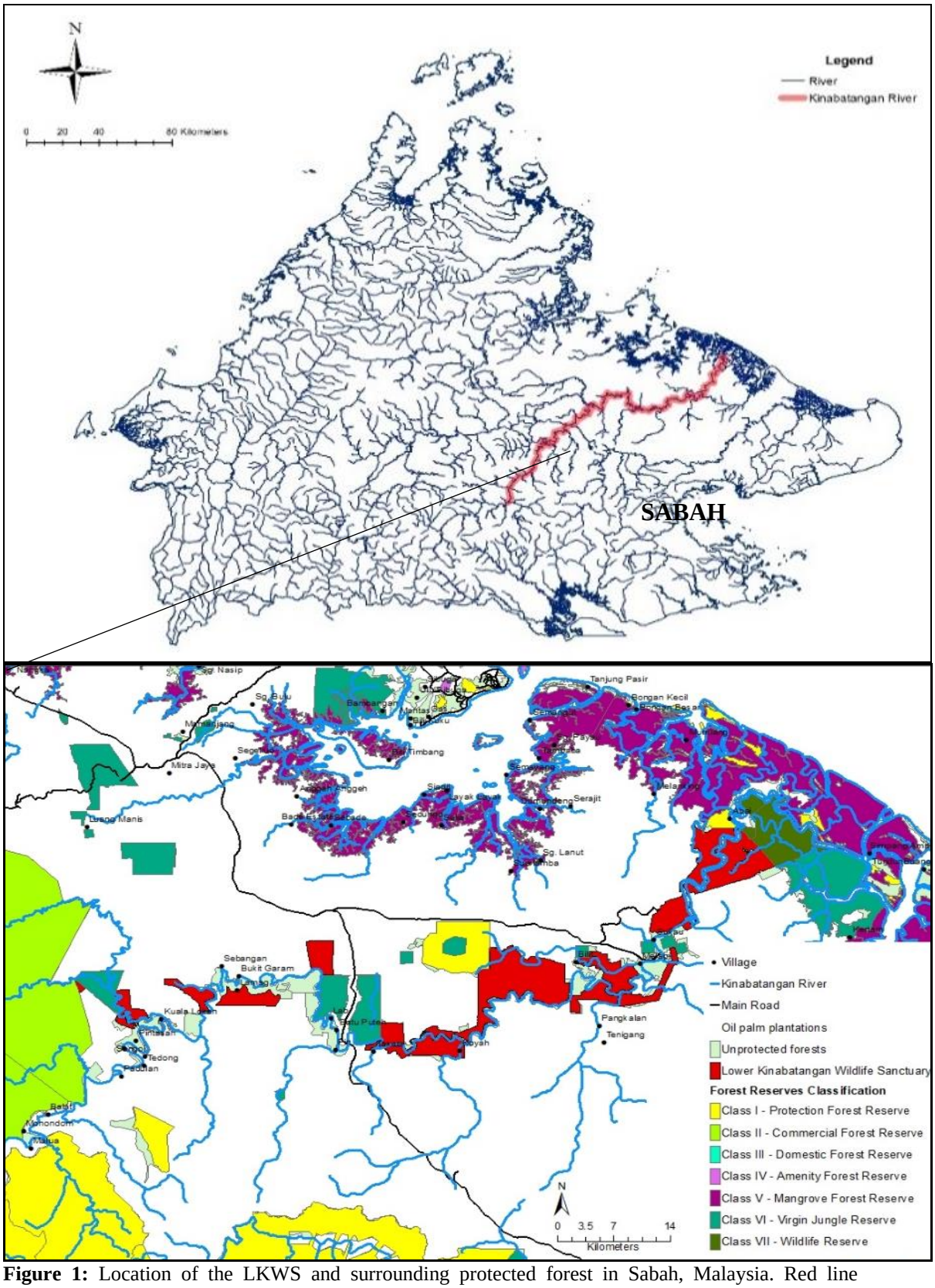


Figure 1: Location of the LKWS and surrounding protected forest in Sabah, Malaysia. Red line denotes the Kinabatangan River in large extent map.

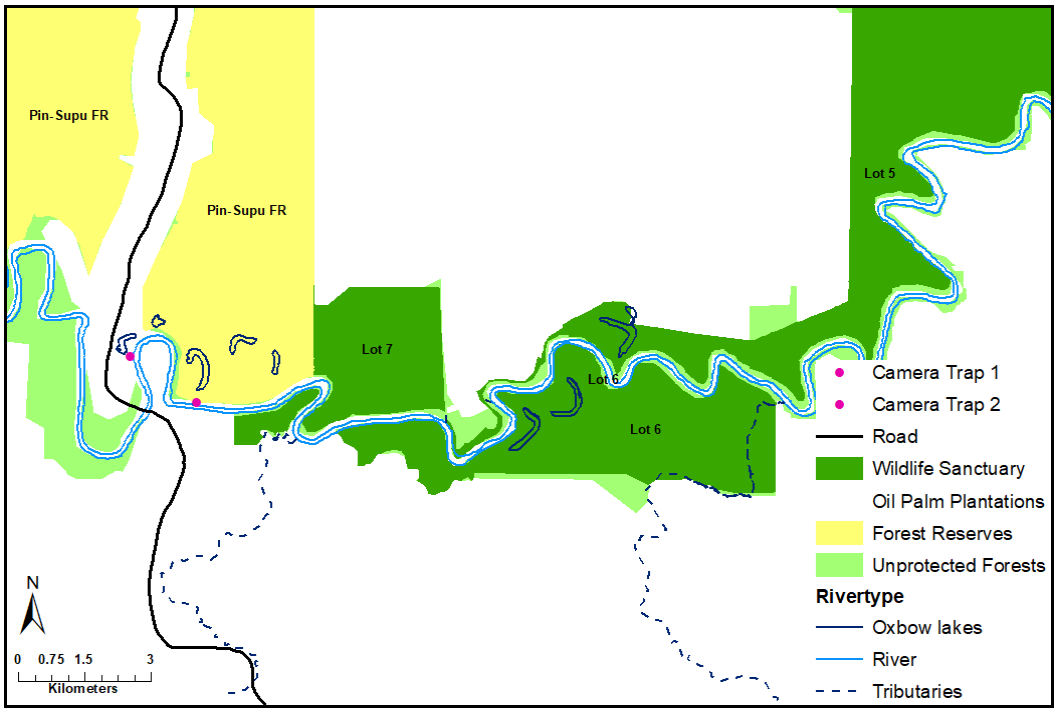


Figure 2: Location of camera trap stations within Lots 5, 6 and 7 in LKWS.

Data entry and analysis

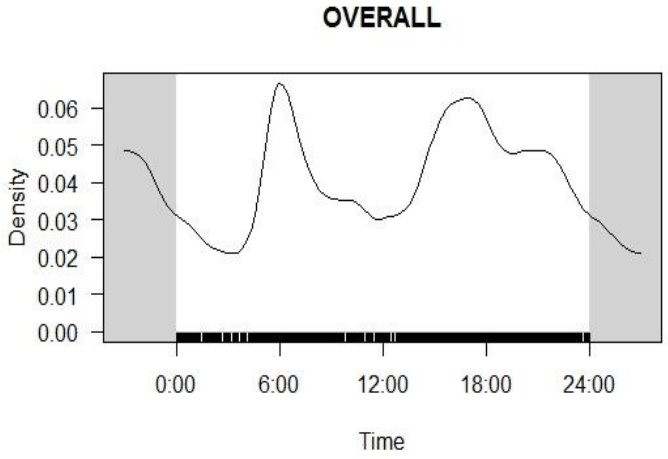
Camera trap images were manually selected and photos not containing otters were excluded from statistical analysis. Metadata extraction was completed using ExifTool (version 9.6.8.0), which included the file name, time, date, moon phase and temperature from each selected photograph. Each burst of three images was considered a single capture, and capture events were further separated using an interval of >30 minutes between photos to avoid pseudoreplication (Vickers et al., 2017; Yasuda and Tsuyuki, 2012). Group size was disregarded for activity pattern determination; as such a photograph containing more than one otter was considered a single event. As a methodology, it is important to note that the resulting activity pattern model generated from these otter photographs represents holt-based behaviours; other activities outside the camera trap view such as hunting activity are not presented. The day-night cycle remains constant throughout the year within the study site, as sunrise occurs at 0600 h and sunset 1800 h, local time (GMT +8). Nocturnal wildlife activity in Borneo can be categorized as 1900 h - 0500 h, diurnal activity between 0700 h - 1700 h and the remaining time; 0500 h - 0700 h and 1700 h - 1900 h was categorized as crepuscular activity (Ross et al., 2013). Following the methodology of Ridout and Linkie (2009), otter activity pattern was modelled using kernel density estimates and the package 'overlap' (Meredith and Ridout, 2014). Statistical analyses were conducted in RStudio software (v. 3.3.3, R Core Development Team, 2018).

RESULTS

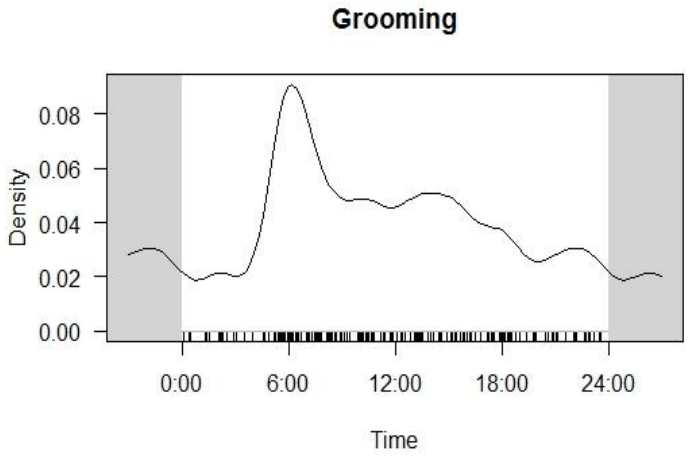
A total of 46,245 images of otters were collected from the four camera traps across 916 camera trap-nights. Based on the combined images from all four camera traps, regardless of exact position, *L. perspicillata* demonstrated two activity peaks; 0600 h and between 1600 h - 1800 h, which indicates that otters were most likely to be captured by the camera traps during dawn and dusk (Figure 3(a)). Moderate otter activity was recorded at 1200 h and between 1900 h - 2400 h, while the lowest

activity was recorded during the night between 0000 h - 0500 h. Grooming activity pattern was generated using the same modelling parameters (see Figure 3(b)) and grooming activity peaked at 0600 h, while the lowest grooming activity recorded was between 0000 h - 0300 h. Using the same model, a sprainting site activity pattern was also generated (see Figure 3(a)). Based on the result obtained, two temporal peaks in sprainting behaviours were recorded; the first peak occurred at 0800 h and the second peaked at 1700 h. The lowest sprainting activity recorded was at 0300 h and 1200 h.

a



b



c

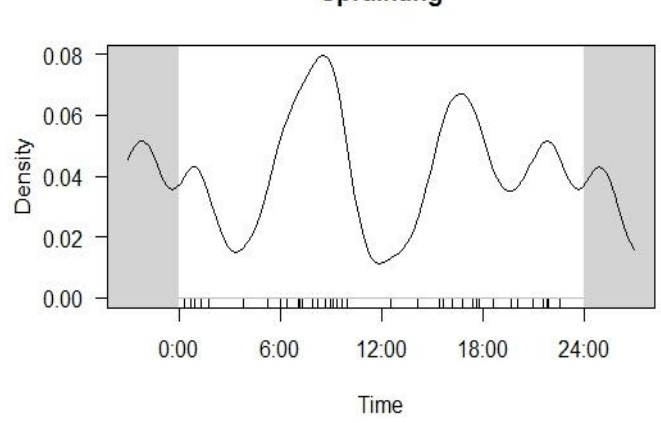


Figure 3: Daily activity patterns for *L. perspicillata* in LKWS based on photographs collected from: (a) all camera traps, (b) a grooming site (1 camera trap) and, (c) a sprainting site (1 camera trap). The grey areas represent an extension of the diel given its circular nature, black marks along the horizontal axes indicates individual camera trap events containing otters.

DISCUSSION

This study has produced the first documented model of the activity pattern of *L. perspicillata* in Sabah, Malaysian Borneo and this information will help to understand better otter behaviour in this region. The findings indicate that the holt-based activity patterns of *L. perspicillata* in LKWS was mainly crepuscular and this study broadly agree with Hussain (2013), who studied the same otter species in India using radio telemetry. However, these findings are in direct contrast with other *L. perspicillata* studies, which suggests that this species is mainly diurnal (Foster-Turley, 1992; Khan et al., 2010; Kruuk, 2006; Payne et al., 2007).

The crepuscular behavior of the Kinabatangan otters in contrast to other regions could be influenced by the differences in the availability of prey, human disturbances or ambient temperatures (Hussain, 2013). Our recorded moderate otter activity at noon might be associated with the high tropical temperatures in Sabah. High ambient temperatures will increase otter energy expenditure, directly affecting otter physiology (Anoop and Hussain, 2004; Foster-Turley, 1992; Hussain, 2013). During these temperature spikes, otters could be resting inside the holts, and therefore were not visible in front of the camera trap. Mean annual temperature in Sabah range from 25 - 30°C, and maximum temperatures are reached at midday and could exceed 32°C (Malaysian Metrological Department, 2017). However, lower temperatures (18 - 20°C) are recorded throughout the night and early morning (Malaysian Metrological Department, 2017), which could help explain our recorded otter activity peaks in the early morning. Moreover, fish, the main prey source for *L. perspicillata*, activity may also be affected by the high afternoon temperatures in Sabah; perhaps fish hide in cooler environments during these times and become active again when temperature is more tolerable (Hussain, 2013; Kruuk, 1995).

Contrastingly, low nocturnal temperatures may increase otter activity. However, in this study, otter activity was moderately low during the night. Perrin and Carranza (2000) reported spot-necked otter (*Hydrictis maculicollis*) activity was positively correlated with the detection of prey, such that low detection of fish during the night caused the otters to become less nocturnally active. The above statement suggests that *L. perspicillata* in the study area might be actively hunting on the river during the day when their visibility is at the best, however, hunting activities were not detected due to the location of our camera trap.

Another possible explanation that affects the otter activity pattern is the presence of saltwater crocodiles (*Crocodylus porosus*) in the study site. Otters may display behavioural changes to adapt with their surroundings, and this could include adapting their activity patterns to avoid predation risk from *C. porosus* or to minimize interspecific competition for fish. Saltwater crocodiles were documented actively hunting at night in the study area, although some satellite-tracked individuals displayed elevated activity peaks at crepuscular times (Evans, 2016). It is suggested that the increases in holt-based activity by *L. perspicillata* may be in response to the presence of saltwater crocodiles. Indeed, Hussain (1993) reported avoidance of mugger crocodile (*Crocodylus palustris*) basking sites. In other regions, otter species co-occur with a range of crocodilian species (Hussain, 2013; Kruuk, 2006; Reed-Smith et al., 2015; Ribas et al., 2012), but little is known concerning the interactions between these two river predators.

Grooming site utilisation of *L. perspicillata* in the LKWS was mostly recorded in the morning, and this may be associated with otter's natural behaviour; otters groom themselves after hunting bouts. After diving under water, otters need to dry their fur to maintain its insulating ability (Hussain, 2013; Kruuk, 2006). Foraging

sessions of *L. perspicillata* have been observed and recorded mostly in the morning and evening (Hussain, 2013; Kruuk, 1992). Therefore, our recorded increase in morning grooming activity might relate to morning hunting activity. Even though *L. perspicillata* have previously been reported to actively hunt during the evening, we recorded low grooming activity in the evening. The findings may suggest that *L. perspicillata* in the region may have multiple grooming sites and they were grooming at other sites in the evening, outside of the camera trap view.

Results from the modelled sprainting activity pattern presented sprainting peaks in the morning and evening. Similar to grooming behavior, sprainting has also been related to hunting bouts (Kruuk, 1992), which could explain the high sprainting activity in the morning and evening. Our modelled sprainting activity pattern presents as a bimodal wave across the diel except noon, which indicates that otters are constantly sprainting throughout the day. Otters are territorial mammals and often mark their territory with repetitive sprainting (Brzeziński and Romanowski, 2006; Kruuk, 1992; Shenoy et al., 2006; White et al., 2003). Our reported decrease in afternoon sprainting activity may be also due to the increase of grooming activity during that time. Other studies (Anoop and Hussain, 2004; Shenoy et al., 2006) have reported that smooth-coated otter may spraint at their grooming site. However, in this study, no spraint was detected at the grooming site, suggesting differences in behaviour of the same species in other regions.

Although camera traps have been widely used to record wildlife behaviour, there were several limitations intrinsic to the usage of this methodology in this study. Camera traps were removed several times due to flooding. It would be interesting to record otters' behaviour and activity patterns outside their holts and associated sites during the flooding season; a waterproof camera trap could be used for such future monitoring work. In addition, activity data were limited to the behaviour that occurred within the camera trap view, and activity beyond this view was not recorded, and thus, not included in these preliminary activity models. For future work, other methods such as habituation observation studies, satellite tracking or radio telemetry, as per Hussain (2013), could be incorporated together with camera trapping to provide more detailed activity patterns for this species. Moreover, setting up the camera traps for a longer period could be useful for monitoring otter group demographics, group health and reproduction cycles over the years. Camera trapping can be easily adopted to study this species in the future, however, targeted questions and an awareness of the methodological limitations of the technology are required for effective future research. These preliminary activity patterns determined by this study serve as valuable baseline knowledge on how this species persists in Borneo, specifically in a degraded and human-modified landscape.

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RÉSUMÉ

MODÈLES D'ACTIVITÉ DE LA LOUTRE A PELAGE LISSE (*Lutrogale perspicillata*) LIES A LA CATICHE, DANS LE SANCTUAIRE DE LA FAUNE SAUVAGE DU KINABATANGAN INFÉRIEUR, SABAH, MALAISIE

Bien qu'elle soit l'une des régions les plus riches en biodiversité du monde, on sait peu de chose sur l'écologie des loutres à Bornéo. Nous avons mené une étude pour documenter les schémas d'activité de la loutre à pelage lisse, *Lutrogale perspicillata*, dans des habitats de plus en plus perturbés et fragmentés de la réserve faunique inférieure de Kinabatangan (LKWS), située dans l'État malaisien du Sabah, au nord de Bornéo. L'objectif était de rassembler des informations écologiques pour avoir des données de base et mieux comprendre le comportement de la loutre dans cette région du Sabah. Nous avons installé des pièges photos à proximité des catiches, des sites de toilettage et d'épreintes fréquentés par la loutre pendant 15 mois non consécutifs et avons utilisé les photos pour modéliser les schémas d'activité de la loutre à l'aide d'un modèle d'estimation de la densité du noyau. Les résultats ont montré que *L. perspicillata* dans le LKWS était principalement crépusculaire, l'activité de la loutre se situant principalement tôt le matin (600 h) et en fin d'après-midi (1600 h à 1800 h). Les activités de toilettage ont culminé à 600 h, tandis que les activités d'épreintes ont atteint leur pic à 800 h et à 1700 h. Nous suggérons que les schémas d'activité de *L. perspicillata* pourraient être influencés par la disponibilité en proies, les perturbations humaines et la pollution de l'environnement.

RESUMEN

PATRONES DE ACTIVIDAD EN LA MADRIGUERA, DE NUTRIAS LISAS (Lutrogale perspicillata) EN EL SANTUARIO DE VIDA SILVESTRE DE KINABATANGAN INFERIOR, SABAH, MALASIA

A pesar de ser una de las regiones más biodiversas del mundo, no se sabe mucho sobrre la ecología de las nutrias en Borneo. Condujimos un estudio para documentar los patrones de actividad de la nutria lisa, *Lutrogale perspicillata*, en hábitats con disturbio y fragmentación creciente en el Santuario de Vida Silvestre de Kinabatangan Inferior, ubicado en el estado malayo de Sabah, Borneo del norte. El objetivo fue obtener información ecológica para establecer datos de base para entender mejor el comportamiento de las nutrias en esta región de Sabah. Desplegamos cámaras-trampa en madrigueras activas de nutria, y sitios de marcación y acicalamiento, durante 15 meses no-consecutivos, y utilizamos las fotos para modelar los patrones de actividad de las nutrias en base a modelado de densidad estimada de núcleos (kernel). Los resultados mostraron que *L. perspicillata* en Kinabatangan es principalmente crepuscular, concentrándose la actividad de las nutrias principalmente durante la primera mañana (0600 h) y el final de la tarde (1600 h – 1800 h). La actividad de acicalamiento tuvo un pico a las 0600 h, y la de marcación (fecas) tanto a las 0800 h como a las 1700 h. Sugerimos que los patrones de actividad de *L. perspicillata* pueden estar influenciados por la disponibilidad de presas, el disturbio humano y la temperatura ambiente.

R E P O R T

EURASIAN OTTER *(Lutra lutra)*: EXPLORING EVIDENCE IN NEPAL

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Abstract: The Eurasian otter (*Lutra lutra*) has been reported to be widely distributed in mountain wetlands of Nepal, though recent records have been scarce. The species is categorized as Near Threatened in the National Red List Assessment estimating its population as 1,000-4,000 individuals which is not based on a comprehensive status survey. Here, we review the past reports of the status and distribution of Eurasian otters in Nepal, and provide an update on the basis of literature review and a limited test surveys of some wetlands. We conclude that there has not been a single verifiable and conclusive record of the Eurasian otter in Nepal in recent years. Recent verifiable reports of otters have been entirely of smooth-coated otters. We suggest that there may have been a dramatic countrywide decline of Eurasian otter from their former ranges. Anthropogenic threats, illegal trade and habitat degradation threaten otter species throughout Asia, and reliable scientific and genetic studies are needed to get clear understanding of Eurasian otter status in Nepal.
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Key words: otter, *Lutra lutra*, Nepal, crab-eating mongoose

INTRODUCTION

The Eurasian otter (Linnaeus, 1758) has one of the widest distributions of all Palearctic mammals (Corbet, 1966). Its range extends from Ireland in Western Europe to the Kamchatka Peninsula in eastern Asia, from the Arctic region to north Africa and as far south as Sumatra and Indonesia in Southeast Asia (Hung and Law, 2016). Due to human pressures, Eurasian otters disappeared from or became endangered in most parts of Europe in the 20th century, but are now recovering in many areas (Crawford, 2003; Prigioni et al., 2007; López-Martín and Jiménez, 2008; Loy et al., 2010). In East Asia, the species was declared extinct in Japan in 2012 (Ando, 2008; Hance, 2012) but in 2017, the first record of the species in 38 years was made with a single camera trap photograph (Japan Times, 2018). The species is declining drastically in China (Li and Chan, 2017) and there have been no recorded sightings since the early 1990s in many countries, including Bangladesh, Indonesia, Cambodia and Vietnam (Yoxon and Yoxon, 2019). Less detailed information from Russia and most parts of Asia

suggests that in many countries both abundance and range appear to be in decline (de Silva, 1995; Duplaix and Savage, 2018). The species is listed as Near Threatened by the IUCN Red List and on Appendix I of the Convention on International Trade in Endangered Species (CITES) (Roos et al, 2015).

In Nepal, lack of verifiable data and scant documentation may have resulted in an unclear picture of population status and distribution of Eurasian otters. The presence of the species has been reported in a number of studies in recent decades (Yonzon 1998; Acharya and Gurung 1991, 1994; Acharya, 1997, 2000, 2006; Acharya and Rimal, 2007; Kafle, 2009, 2011). It was predicted to be widely distributed in Mountain Rivers and wetlands (Yonzon, 1998; Acharya 2006; Kafle, 2009; Acharya et al., 2010; Acharya and Rajbhandari, 2011; Jnawali et al., 2011; Acharya and Rajbhandari, 2012a,b). It is categorized as Near Threatened on the National Red List Assessment of Nepal, which estimates its population as 1,000-4,000 individuals, but this estimate is not based on a comprehensive status survey (Agenda Survival, 1991; Jnawali et al., 2011). The species is not included on the protected list of the National Parks and Wildlife Conservation Act (1973), which restricts killing, hunting and capturing animals and imposes regulations to curb illegal trade. However, the 2002 Amendment of the Aquatic Life Protection Act (1961) gives legal protection to two species of otters, the Eurasian otter and smooth-coated otter, both within and outside protected areas (Acharya and Rajbhandari, 2011, 2012c). Nepal is also a signator of CITES, which forbids trade in the Eurasian otter.

Here we review information from recent research on otters in various physiographic zones of Nepal to assess whether there is current incontrovertible evidence of Eurasian otter presence in the country.

LITERATURE REVIEW

Published articles, thesis reports, management plans and Environmental Impact Assessment reports from plausible otter locations were assessed. Eurasian otters have been reported from the following protected areas in Nepal: Annapurna Conservation Area, Makalu Barun National Park(NP), Koshi Tappu Wetland, Rara NP, Bardia NP, Ghodaghodi Lake Area as well as 21 districts: Saptari, Sunsari, Chitwan, Bardia, Kapilvastu, Bara, Kailali, Kanchanpur, Kaski, Bajhang, Bajura, Ilam, Panchther, Taplejung, Gorkha, Lamjung, Myagdi, Mugu, Solukhumbu, Manang and Sankhuwasabha (Kafle, 2009; Thapa Chhetry and Pal, 2010; Acharya and Rajbhandari, 2011a; Jnawali *et al.* 2011), and the Arun River, Seti River and its tributaries, Bhote Kosi River and Tama Kosi River (K. Saha, 2011 pers. comm. with P. Acharya). Some of these studies used direct sightings or indirect signs (tracks, scats, dens, resting sites, slides and grooming sites) to document their presence (Acharya and Gurung, 1991, 1994; Yonzon, 1998; Acharya et al., 2010, Acharya and Lamsal, 2010; Thapa Chhetry and Pal, 2010; Acharya and Rajbhandari 2011, 2012a, b, d; Paneru, 2014), but many were based on community perception surveys (Agenda Survival, 1991; Acharya 1997; Bhandari and G.C.,2008; Kafle, 2009, 2011; Acharya & Rajbhandari, 2011; Jnawali et al., 2011; Acharya, 2016, 2017).

Photographic evidence of the smooth-coated otter has been taken from the Khauraha, Geruwa and Karnali Rivers of the Karnali River System in Bardia National Park (Acharya, 2016, 2017; Jha 2018), the Babai River of Babai Valley (Acharya and Rajbhandari, 2012d; Bhandari, 2019), and Suklaphanta National Park (Thapa, 2019), all appearing to be suitable otter habitats. Yet there is no recent photographic evidence of Eurasian otters from these areas. The only photographic evidence of Eurasian otters dates from the early 1990s, from Rupa and Begnas Lakes of Kaski District. Eurasian otters appeared to be common then, but anthropogenic pressures from fisherman were rising at that time (Acharya and Gurung, 1991; 1994). After more than a decade, preliminary survey along with sign survey conducted by Bhandari and G.C. (2008) did not confirm Eurasian otter presence at the site.

Eurasian otters were reported in the West Seti River Valley by Yonzon (1998). Bolton (1976) recorded the presence of Eurasian otters in Lake Rara of Rara National Park in far

Western Nepal. The Eurasian otter was a species of concern for local conservation efforts, as significant number of otters were killed by traditional hunters from Humla and Jumla Districts to sell their pelts in India (Yonzon, 1998). Since that time no otter monitoring has been carried out on the Seti River and Rara Lake area, and so no positive reports of Eurasian otters have been recorded recently.

Kafle (2009) and Jnawali et al. (2011) reported the presence of Eurasian otter in Makalu Barun National Park, based on infrequent sightings and key informant's reporting. A study of small carnivores, carried out by Ghimire (2010) with extensive sign surveying, camera trapping and a social survey for over a year and a half in Makalu Barun National Park did not record the presence of Eurasian otters. Nor did a camera trap survey carried out in 2017 to study small carnivores of Tinjure-Milke Forest (Rai et al., 2018). The recent management plan for Sagarmatha National Park and its buffer zone, which covers Solukhumbu District, does not include otters (SNPO, 2016).

A survey of wetlands carried out in Koshi Tappu Wildlife Reserve, which covers part of Sunsari, Saptari and Udayapur Districts of the eastern Nepal, did not record any indirect sign or sightings of Eurasian otters (Acharya, 2002). Another survey of Koshi Tappu, carried out from July 2002 to June 2004 by Thapa Chhetry and Pal (2010) claimed that both smooth-coated otters and Eurasian otters were present based on indirect evidence, but a study in 2013 confirmed the presence only of smooth-coated otters (Chettri et al., 2016). A 2016 camera trap survey carried out to study fishing cat in fish ponds in the Sunsari District and along the Sunsari River recorded several small carnivores, but no otter species (Dahal et al., 2017). A survey carried out in Ghodaghodi Lake Complex area of far western Nepal found no sign of otters (Acharya, 2002). A study in 2007 (Lamsal et al., 2014) claimed the presence of Eurasian otter through direct sightings and indirect signs, but more recent research by Kunwar (2019) in the same study area found no evidence of otters. A preliminary survey of Kanchanjunga Conservation Area, in Taplejung District recorded no species of otters (WWF, 2019). In Chitwan District, indirect signs based on size and shape of tracks claimed the presence of smooth-coated otters in the Narayani River in 2008 (Acharya et al., 2010), but evidence of Eurasian otter has never been recorded (Acharya et al., 2010; Acharya and Lamsal, 2010; Acharya and Rajbhandari, 2012a).

A test case field survey

We conducted a limited survey to search for Eurasian otter presence in some areas where they had been previously reported. From December 2018 to January 2019, we conducted an otter survey along the Budigandaki River and adjoining streams that lie in Bhimsen Rural Municipality and Sahid Lakhan Rural Municipality of Gorkha District (Figure 1). Different from our study site, Kafle (2011) used social surveys and observation of scat in streams of the Pyaudikhola Watershed and Kapring Khola Watershed of Marsyangdi River in the same district. He reported otter presence based on local people's perception and characteristics of the scat he collected: dark grey, with fragments of fish, frog and crab remnants, fragile, and smelling of fish. We sought otter sign (e.g., latrine sites, tracks, scats and dens) on 7 transects of 1 km each along river bank. The transects were chosen purposively based on our key informant and preliminary surveys. Surveys covered adjacent 5 meters of both sides of transect. The survey was conducted in December when river was low and sand banks were remained exposed. Following the sign survey, seven field cameras were also placed in location of likely otter activity for a total of 140 camera working days and nights.

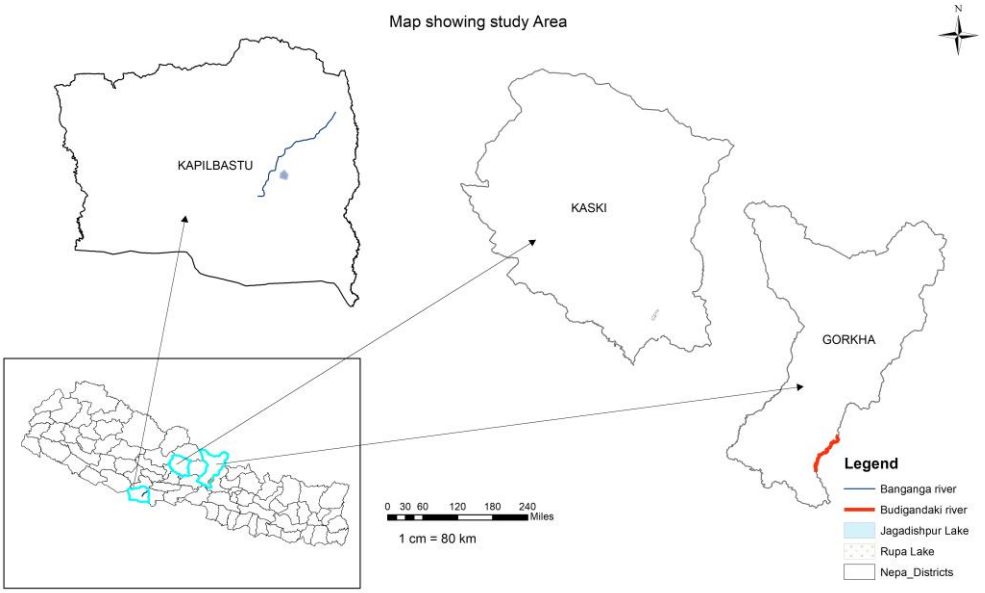

Figure 1: Map of Nepal showing field surveyed sites for *Lutra lutra*

Key informants were interviewed and local people were surveyed using a semi-structured questionnaire to a sample of 70 purposively selected households living in the vicinity of the River. The perception of respondents towards the otter was measured in strongly agree to strongly disagree (1-5) Likert scale format proposed by Babbie (1995). Chi-square test and likelihood ratio test were also used to understand perception of respondents and relationship between different variables. No sightings, signs and photographs of otters were recorded in our survey and also older aged respondents have supported the statement of declination of otter in the present (Since likelihood ratio = 30.325*, calculated *P*-value 0.002 is less than the tabulated value 0.05) which is probably as the distribution of otters along the watersheds has diminished compared to few decades back. Our questionnaire survey revealed that local people older than 60 years who had sighted otters long ago have not seen otters in the area in the last two decades. Almost entire respondent did not accepted killing otter and no any body parts of otter are owned or used as medicine in the study area. Since the crab-eating mongoose shares the otter's ecological niche, including foraging for crabs (Kruuk, 2006; Thapa, 2013; Rahut, 2013), otter scat may be confused with crab-eating mongoose scat. The questionnaires revealed that many local people confused otters with crab-eating mongooses (*Herepestes urva*). Without genetic analysis, we believe it is difficult to positively identify the scat to species based on visual traits alone.

Similar methods were used in Kapilvastu District of the Western lowlands of Nepal, at Jagadishpur Reservoir (a Ramsar site) and along the Banganga River, with 27 transects of 1 km each and camera trapping for 640 trap nights, from October 20 to January 10, 2018/19. Camera trapping effort of 640 trap nights and the transect survey around the Banganga River and adjoining rivers and Jagdishpur Reservoir (a RAMSAR site) was conducted based upon the focused group discussion with the old people and the local hunters of that area regarding the presence of otters in the site. The study revealed evidences of several small carnivores but no evidence of otters.

A preliminary survey along with sign survey was conducted in Begnas and Rupa Lakes of the Pokhara Valley following informal discussion with locals in March, 2018.The signs of otter was sought along the bank of lakes by continuous survey. The study could not find any evidence of Eurasian otter from the study sites. Local people had mixed perspectives about the presence i.e. older respondents reporting presence of otter before two decades and younger generation don't know about otters and their presence in recent years in the area. The only photographic evidence of Eurasian otters from Nepal is of Rupa lake which dates back to early 1990s (Acharya and Gurung, 1991).

Threats to otters in Nepal

The decline of Eurasian otters in Nepal is likely due to anthropogenic disturbances. In recent decades, populations of all species of otters in Nepal have declined largely because of degradation of natural habitats and hunting (Acharya and Gurung, 1991; Acharya 1997; 2006; 2016, 2017; Acharya and Lamsal 2010; Acharya and Rajbhandari, 2011). Otter habitat is threatened by extraction of sand and stones from bank sides, overfishing, poisoning of prey species, the use of bombs thrown in the river for fishing, removal of shoreline vegetation, firewood and grass cutting, livestock grazing, construction of irrigation intakes, sedimentation, construction of dams, frequent activity of people on river banks, and industrial and agricultural pollution (Acharya and Lamsal, 2010; Acharya, 2017).

Illegal poaching also threatens otters in the country. From 1989 to 2017, 755 skins were seized from poachers in Nepal (Shrestha and Savage, 2018). Although it is unclear how many of these are Eurasian otters because of the difficulty of identifying pelts to species level. In recent decades, populations of all species of otters in Nepal have declined largely because of hunting and loss of natural habitats (Acharya and Gurung, 1991; Acharya 1997; 2006; 2016, 2017; Acharya and Lamsal 2010; Acharya and Rajbhandari, 2011). They are hunted for their pelt, meat and internal organs for indigenous medicine (IOSF, 2014). In Rupa and Begnas Lakes, otters were killed by trapping with nets, or by chasing the animal to exhaustion and then shooting it (Agenda Survival, 1991; Acharya and Gurung, 1994).

The 1961 Aquatic Life Protection Act provides for some legislative protection for aquatic habitats, prohibiting the use of poisonous or explosive materials into a water source, or destroying any dam, bridge, fish ladder or water system with the intent of catching or killing aquatic life. Thus far, however, there has been no reported case of a person being prosecuted under the Act (Belbase, 1999). A recent amendment to the act has added smooth-coated and Eurasian otter species to the protected species list (Nepal Gazette, 2002), which may be crucial in protecting the biodiversity of aquatic systems through interagency cooperation (Acharya, 2006b).

CONCLUSIONS

A thorough review of the literature on Eurasian otters in Nepal and limited field surveys suggest that there has not been a single verifiable and conclusive record of the Eurasian otter in Nepal in recent years. Recent reports of otters in the country have been entirely of smooth-coated otters, for example in Karnali River system in Bardia National Park and the wetlands of Suklaphanta National Park. We suggest that populations of Eurasian otters have undergone a dramatic countrywide decline. At present, the lack of data to assess the true status of Eurasian otters in Nepal can only be remedied by scientific and genetic surveys.

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RÉSUMÉ : LA LOUTRE EURASIENNE (*Lutra lutra*) : RECHERCHE D'INDICES DE PRESENCE AU NÉPAL

Bien que les informations récentes soient peu nombreuses à ce sujet, la loutre Eurasienne (*Lutra lutra*) serait largement répandue au Népal dans les zones humides de montagne. L'espèce est considérée comme quasi menacée au niveau de la Liste rouge nationale. L'estimation de la population, non fondée sur un suivi exhaustif, serait de 1 000 et 4 000 individus. Dans la présente publication, nous passons en revue les rapports antérieurs sur le statut et la répartition des loutres eurasiennes au Népal et fournissons une mise à jour sur base d'une revue de la littérature et d'un nombre limité de suivis tests de certaines zones humides. Nous concluons qu'il n'y a pas eu une seule donnée fiable et convaincante sur la loutre eurasienne au Népal ces dernières années. Les rapports fiables récents sur les loutres concernent uniquement la loutre à pelage lisse. Nous suggérons donc qu'il y ait peut-être eu un déclin dramatique à l'échelle nationale de la loutre eurasienne par rapport à son ancienne aire de répartition. Les menaces anthropiques, le commerce illégal et la dégradation de l'habitat menacent les espèces de loutres dans toute l'Asie. Des études scientifiques et génétiques fiables sont nécessaires afin de bien comprendre le statut de la loutre eurasienne au Népal.

RESUMEN: **LA NUTRIA EURASIÁTICA (*Lutra lutra*): EXPLORANDO EVIDENCIAS EN NEPAL**

Se ha informado que la nutria eurasiática (*Lutra lutra*) está ampliamente distribuida en los humedales de montaña de Nepal, aunque son escasos los registros recientes. La especie está categorizada como Casi Amenazada en la Evaluación Nacional de Lista Roja, estimándose su población en 1.000-4.000 individuos, lo que no se basa en un relevamiento sistemático de su status. Aquí, pasamos revista a los informes pasados de status y distribución de la nutria eurasiática en Nepal, y proporcionamos una actualización sobre la base de revisión bibliográfica y relevamientos limitados de algunos humedales. Concluimos que no ha habido ni un solo registro verificable y concluyente de la nutria eurasiática en Nepal en años recientes. Los informes verificables recientes de nutrias, son todos de nutria lisa. Sugerimos que puede haber habido una dramática declinación de la nutria eurasiática a escala de todo el país. Las especies de nutrias en toda Asia están amenazadas por factores antropogénicos, comercio ilegal y degradación del hábitat, y se necesitan estudios científicos y genéticos confiables para obtener un claro entendimiento del status de la nutria eurasiática en Nepal.

सारांश:

कालो ओत: नेपालमा प्रमाण खोज्दै

कालो ओत नेपालको पर्वतीय सिमसार क्षेत्रमा व्यापकरूपमा पाइने भनिएको भएपनि हालका रेकर्डहरू भने विरलै छन्। यस प्रजातिलाई नेपालको स्तनधारी बन्यजन्तुको रातो सूचीमा संकट नजिक भनेर वर्गीकृत गरि यसको संख्या १,०००-४,००० अनुमान गरिएको छ जुन विस्तृत सर्वेक्षणमा आधारित छैन। यस रिपोर्टमा हामीले सोधपत्रको अध्ययन र सिमसार क्षेत्रमा सीमित परीक्षण सर्वेक्षणको आधारमा नेपालमा कालो ओतको स्थितिबारे व्याख्या गरेका छौ। हामी यस्तो निष्कर्षमा पुगेका छौं कि हालका वर्षहरुमा नेपालमा कालो ओतको एउटा पनि प्रमाणिकरण गर्ने निर्णायक रेकर्ड छैन। ओतहरूको हालको सम्पूर्ण रिपोर्टहरूले नेपालमा खैरो ओत पाइने प्रमाणित गर्छ। तसर्थ कालो ओतको संख्या देशव्यापीरुपमा गिरावट आएको हुन सक्छ भन्ने हाम्रो आंकलन छ । मानविक गतिविधि, अवैध व्यापार र बासस्थानको विनासले एशियाभरि ओतका प्रजातिहरूलाई खतरा निम्त्याएको छ। नेपालमा कालो ओतको स्थिति बुझ्न वैज्ञानिक र आनुवंशिक अध्ययन आवश्यक छ।

A R T I C L E

FENCED FISHERIES, EURASIAN OTTERS (*Lutra lutra*) AND LICENCED TRAPPING: AN IMPACT ASSESSMENT

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Abstract: The endangered Eurasian Otter (*Lutra lutra*) became a protected species in England and Wales in 1978. The gradual recovery of the species coincides with the rise in specimen fishing on stillwater fisheries and increased concerns about predation. Although otter-proof fencing has been identified as the most effective medium-long term solution, the lack of a formalised legal mechanism to remove otters from fenced fisheries compromised livelihoods and otter welfare. Recognising this, the UK Wild Otter Trust (UKWOT) successfully lobbied for a licence to humanely trap and remove them. This paper examines the initial media and stakeholder responses to Natural England introducing the CL36 'Class Licence' to live capture and transport Eurasian otters (*Lutra lutra*) that are trapped in fenced fisheries to prevent further damage. The paper analyses the UKWOT 'Interventions Spreadsheet' for the three years of the CL36 licence (November 2016 to June 2019) and the AT Fishery Management Advisors (FMA) 'Otter Log' (March 2017 to March 2019), to trace otter-related enquiries. Finally, the paper assesses the impact of the licence in practice, with reference to the successful live trapping and removal of otters from fenced fisheries.

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INTRODUCTION

Endangered in England from the 1970s (O'Connor et al, 1977; Chanin and Jefferies, 1978; Chanin, 1985; Kruuk, 2006), the Eurasian Otter (*Lutra lutra*) became a protected species in England and Wales under the Conservation of Wild Creatures and Wild Plants

(Otters) Order 1977 in 1978. With added protection under the Wildlife and Countryside Act 1981, Conservation of Habitats and Species Regulations 2010, and as a European Protected Species (EPS), otter populations gradually recovered (Lenton et al., 1980; Strachan et al., 1990; Strachan and Jefferies, 1996; Crawford, 2003; Crawford, 2010). During the First National Otter Survey of England, for example, only 170 of the 2,940 sites (5.8%) surveyed showed evidence of otters (Lenton et al., 1980); this increased to 1726 (59%) on the Fifth National Otter Survey of England (Crawford, 2010).

Recreational angling is worth an estimated £1.4 billion a year to the English economy (GOV.UK, 2018). During the relative absence of otters, specimen fishing on stillwater fisheries became the most popular and most profitable form of angling in England (Allen and Pemberton, 2018; 2019; Angling Trust and Institute of Fisheries Management, 2018; Paisley and Heylin, 2019) – there are now 9,546 registered stillwaters in England (Allen and Pemberton, 2019).

Coinciding with the recovery of an apex predator, "there has been increased concerns about predation" (Crawford, 2010 no pagination), with otter-proof fencing identified as "the only effective long term solution" (Jay et al, 2008 p. 3) to prevent otter predation on stillwaters. This has led to commercial enterprise in the form of otter-proof fencing businesses, with the largest two companies installing the equivalent of over 37 miles of fencing (Otter Stop Ltd) since 2013 and over 26 miles (Embryo Angling) since 2015. Figure 1 is a collation of the fencing projects (121 sites) publicly listed on the Otter Stop Ltd (89 sites) and Embryo Angling (32 sites) websites - this gives an indication of the geographic spread of otter fencing installations across England by these two companies alone. It is worth noting there are hundreds of other stillwater fisheries which have been fenced by alternative fencing contractors or the clubs themselves.

National strategies have also been established in response to reported economic losses from otter predation. A total of 120 stillwater fisheries received funding towards otter-proof fencing during the period of 2010-2018 – as shown in Figure 1. From 2010 to 2014 inclusive, financial support for otter-proof fencing was provided directly from the Environment Agency at an estimated total value of £125,000. Rod licence contributions to the Environment Agency have also been made available to fisheries through the Angling Improvement Fund (AIF). Since 2015 the Angling Trust has awarded £488,623 worth of small AIF grants for otter-proof fencing projects in England. During this time, two full-time Fishery Management Advisors (FMAs), funded by the Environment Agency through rod licence income, have been employed by the Angling Trust to "advise fishery managers on how to protect their fisheries from (avian and) otter predation, including advice about fencing" (Angling Trust, 2019).

Despite this, whenever an otter actually breached otter-proof fencing and went on to prey on specimen fish within stillwater fenced fisheries, there was no formalised legal mechanism available to remove them; hence, economic losses could continue and/or the welfare of otters could be compromised as some fishery managers and/or anglers may be tempted to eliminate them through illegal practices (Allen and Pemberton, 2019).

The UK Wild Otter Trust (UKWOT), which started as a Facebook group in August 2013 and became a registered charity (1167746) in June 2016, recognised this issue. During this time UKWOT changed from being a largely photography-centric group where members shared otter sightings and otter spotting advice, to an online community which encouraged 'healthy debate' between conservationists, otter enthusiasts and anglers. Working closely with the Angling Trust since 2014, it was agreed that a practical, legal solution was needed to humanely manage such situations; UKWOT then lobbied Natural England for a formal class licence arrangement (Allen, 2016). Otter specialists with trapping experience were consulted about traps and trapping, and the RSPCA agreed to provide ongoing welfare guidance and support. Financial backing came from Embryo Angling Habitats (2016) who offered UKWOT funding "on a case by case basis", and to help "some clubs who can't release money quickly" with fencing costs. After two years of planning and negotiations, UKWOT secured the first Natural England initiative 'Class Licence' to humanely trap and remove otters inadvertently trapped in fenced fisheries (Allen, 2016).

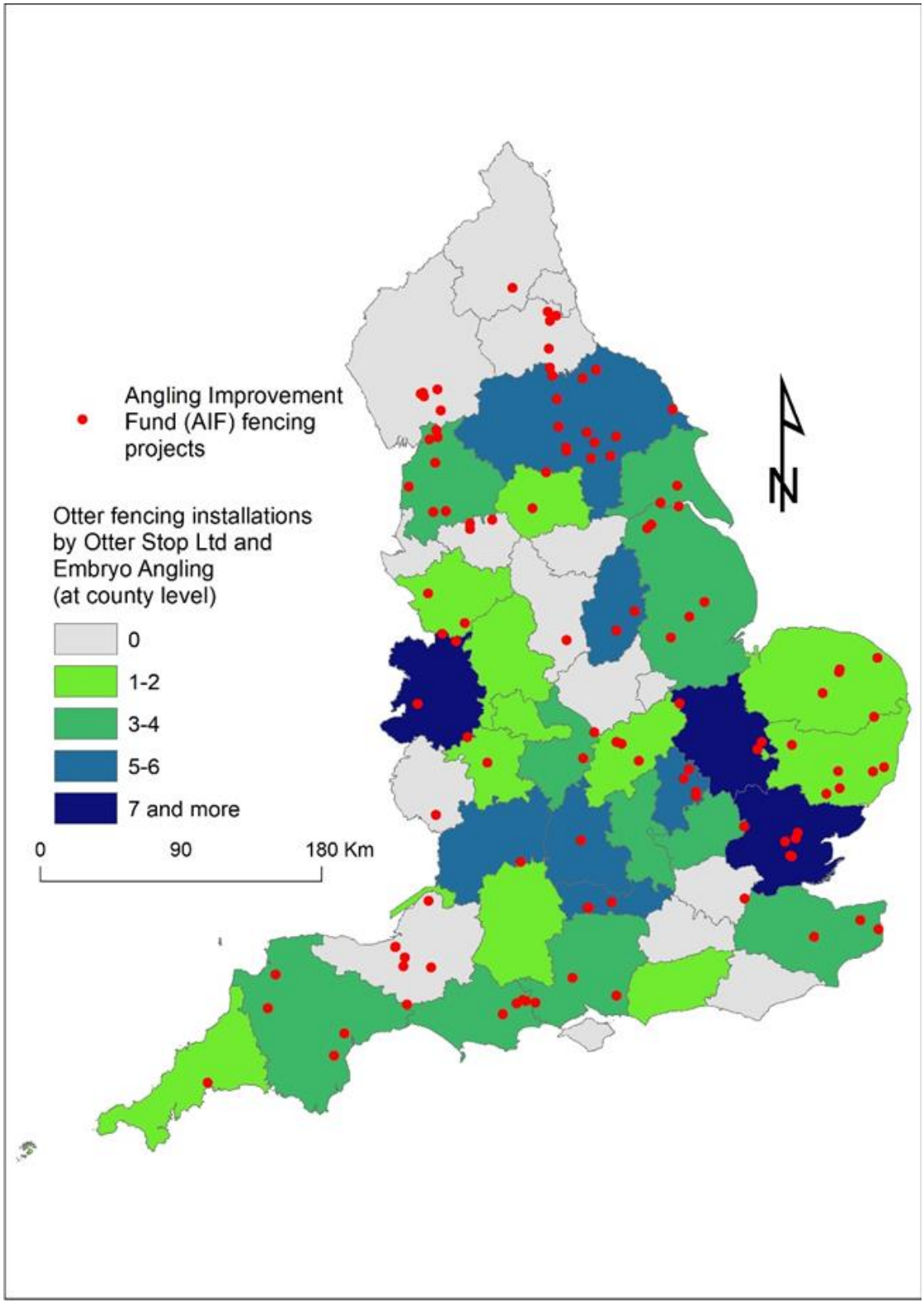

Figure 1: Angling Improvement Fund (AIF) fencing projects and number of otter fencing installations per county by Otter Stop Ltd and Embryo Angling

The CL36 licence "permits persons registered" "to capture and transport live Eurasian otters (*Lutra lutra*) for the purposes of preventing serious damage to fisheries", "at fisheries that have been appropriately fenced to prevent access by otters." The terms and conditions for acting under the licence set out the standards and procedures for trapping and releasing animals, recording and reporting requirements, and otter fencing specifications. Those applying for the licence must also: (i) identify where an otter has got into the fishery - it is the

responsibility of the fishery to fix a broken fence before a trap is set; (ii) use appropriate live capture traps positioned away from areas that could flood; (iii) de-activate a trap if heavy rainfall is predicted; (iv) attend any trap set to capture live otters within 3 hours; (v) transport and release the trapped otter immediately outside the fishery fence after a visual assessment of the trapped otter's health; and (vi) get the landowner's permission before action is taken (GOV.UK, 2019a).[2]

This paper examines initial media and stakeholder engagement with the CL36 licence – including press releases from Natural England and UK Wild Otter Trust, and responses to the announcement from the IUCN/SSC Otter Specialist Group (OSG) and the Predation Action Group (PAG). The paper also analyses the UKWOT 'Interventions Spreadsheet' derived from a records database for the first three years of the CL36 licence (November 2016 to June 2019), and the Angling Trust Fishery Management Advisors (FMA) 'Otter Log' (April 2017 to March 2019) to trace otter-related enquiries. Finally, the paper assesses the impact of the licence in practice, with reference to the successful trapping of otters under licence.

METHODS AND MATERIALS

Licenced trapping operatives:

Natural England set up an approved training course for otter trapping led by a qualified ecologist and bushcraft instructor. Three operatives from UKWOT, two from the Angling Trust, and one independent angler attended the one-day course in June 2016, qualifying as the first licenced otter trapping operatives in England. Further CL36 training courses have been held by Natural England adding another nine registered individuals, including representatives from the RSPCA, Natural England, and angling clubs.

Licence communication:

UKWOT press releases were published on Daniel Allen's (UKWOT's Media and Policy Advisor) LinkedIn profile, posted on the UWKOT Facebook group, shared through Twitter accounts @dr_dan_1 and @wildottertrust, and emailed directly to media contacts. This led to local and national media coverage.[3] Daniel Allen also presented details about the new licence in person during the IUCN Otter Specialist Group UK Meeting at the Chestnut Centre Otter and Owl Wildlife Park in Derbyshire on October 15 2016.

UKWOT 'Interventions Spreadsheet' derived from a records database:

A requirement of the CL36 licence is "record keeping and reporting for each site where the licence is used." From November 2016 to May 2019, all CL36 enquiries to the charity were recorded in a database by UKWOT trapping coordinator Lesley Wright. The anonymised spreadsheet in this article is derived from that records database (UKWOT, 2019). Trapping operatives employed as Fishery Management Advisors by the Angling Trust operate under UKWOT policy, and any CL36 trapping jobs are included in this spreadsheet.

Angling Trust FMA 'Otter Log':

All otter-related enquiries to the Angling Trust are dealt with and logged by the Fishery Management Advisors. A data share collaboration was set up between Keele University and Angling Trust to gain access and analyse this dataset.

RESULTS AND DISCUSSION

Media engagement and impact:

On September 26 2016 Natural England made a public announcement on their website: "The licence will speed up the process for capturing and relocating otters that manage to get in to fisheries that have been fenced to exclude them. Having a group of trained people who

[2] In March 2019 the Agreement on International Humane Trapping Standards came into force across England, Scotland and Wales. This 'sets out clearly-defined minimum trap humaneness standards and trap testing procedures', providing further protection to otters, badgers, beavers and pine martens (GOV.UK, 2019b).

[3] UKWOT started a monthly electronic newsletter in February 2018 to communicate charity developments.

can operate under the licence will avoid the need for individual licence applications. The process ensures the protection of otters." James Cross, Chief Executive of Natural England, added: "The new class licence is a common-sense approach that will benefit both otters and fisheries – and embodies Natural England's commitment to working with partners and safeguarding our wildlife for everyone" (GOV.UK, 2016).

UKWOT shared a press release about the development on September 29 2016. Founder and Chair Dave Webb explained: "I am very excited about this breakthrough for the UK Wild Otter Trust. It is an important step forward in otter conservation and it demonstrates what can be achieved by working alongside the angling fraternity. Otter predation can be an issue for fenced fisheries. This 'Class Licence' will give these fisheries and anglers an avenue to remove the trapped otter legally and humanely." Media and Policy Advisor Daniel Allen added: "The UK Wild Otter Trust has taken a pragmatic approach to otter predation in fenced fisheries, and now offers a practical, non-lethal, legal solution to owners of fenced fisheries." The position of the Angling Trust was included in the UKWOT press release. Chief Executive Mark Lloyd stated: "This is a welcome response to the representations we have been making to Natural England to deal with the potential problem of otters occasionally getting trapped inside the fences that have been installed on fisheries throughout the country, with support from the Angling Improvement Fund. Our expert Fishery Management Advisors will now be able to help fishery owners and angling clubs by legally trapping the animal and placing it outside the fence. The licences are another step forward in our wider strategy for managing the impact of predation on fish and fishing" (UKWOT, 2016).

Online media coverage ranged from local press coverage in the North Devon Gazette, 'North Devon wildlife group granted 'first ever' licence to free trapped otters' (Keeble, September 30 2016), to a national feature by BBC Countryfile magazine, 'Otter problems and solutions' (Parr, October 13 2016). On October 14 2016 Anglers Mail reported the 'Breakthrough over otters', stating the licence was "raising hopes the species might lose some of its 'untouchable' status" (Petch, 2016). UKWOT trapping operatives were also interviewed by CARPologyTV (November 21 2016), and appeared on a television item about otters and fisheries on BBC One's Countryfile (January 15 2017). The item, which suggested there was growing pressure from anglers to cull otters, sparked public debate (Press Association, 2017). UKWOT's policy and media advisor responded with a feature in the February 2017 edition of BBC Wildlife Magazine (Allen, online June 28 2017).

Table 1: Examples of UKWOT Media Impact

Date	Media	Feature	Audience
September 29, 2016	Daniel Allen's LinkedIn	UK Wild Otter Trust secures England's first initiative class licence from Natural England for the live capture and transport of the European Otter.	6,977 views
September 30, 2016	North Devon Gazette	North Devon wildlife group granted 'first ever' licence to free trapped otters	41,971 readership
October 13, 2016	BBC Countryfile Magazine	Otter problems and solutions.	264,000 readership
October 14, 2016	Anglers Mail	Breakthrough over otters.	190,000 readership
November 21, 2016	CARPology TV, YouTube	Big otter law change.	12,527 views
January 15, 2017	BBC One's Countryfile.	Otters and fisheries item, featuring UKWOT's trapping operatives.	6.88 million viewers
February 15, 2017	BBC Wildlife Magazine	Separating fact from fiction: anglers and otters. BBC Wildlife Magazine, by Daniel Allen.	240,000 readership
Source: LinkedIn and YouTube views are public; media packs show readerships; BARB (2019) has TV viewers.			

As Table 1 demonstrates, Natural England and UKWOT licence communication led to a readership of over 740,000 and the item on BBC's One's Countryfile was seen by almost 7 million viewers.

IUCN OSG UK response

Otter specialists showed "support for UKWOT driving forward work with the angling community", and recognised "that this is vital to addressing conflict". Individual members of OSG stated that the "project won't solve conflict with fisheries as trapped otters are a small part of the issue", but should be seen as "an opportunity to engage and educate more fisheries owners about the facts on predation, real threats to fish stocks and the need for good quality fencing as part of business planning for fisheries" (OSG UK, 2016). The development prompted discussion and the following points were raised:

1. Communication of the project and licence arrangement gave the impression that otters being stuck inside fisheries is a common occurrence when evidence suggests it is rare.
2. PR should make it clear that trapping is a last resort after other avenues have been exhausted. The first step should be to open a section of fence or install a one-way gate and encourage the otter to exit the fishery, as appears to be required by the licence. Flushing with humans should also be used.
3. Concerns over welfare of trapped otters and lack of experience of operatives, made it essential to have a detailed protocol for dealing with welfare issues and injuries before proceeding, including consulting centres/organisations that might be asked to take in any otters unfit for release.
4. It is not thought necessary at present to have a training programme beyond the number of operatives already trained as there might only be a few instances per year.

Predation Action Group response

Although principally regarded as a breakthrough, the Predation Action Group shared "some natural reservations" about the otter trapping licence on their website. These included:

1. The narrowness of its scope, as the licence only applies to suitably fenced fisheries.
2. The timescales involved in the trapping. Five days' notice are required of any intended trapping – predation can damage fish stocks and livelihoods in that time.
3. Undefined "failed trapping" period and lack of clarity regarding procedures if predation is ongoing and livelihoods affected. PAG favours local licenced lethal control in such circumstances: "If you can't trap it you have to kill it, either under the terms of another licence issued by Natural England, or at the discretion of an 'authorised person' under the existing provisions of the Wildlife & Countryside Act, 1981."
4. The difficulty of trapping otters.
5. Training – the cost ("of the order of £400, plus travel and an overnight stay") and lack of clarity on future training intakes. PAG have "offered to fund the training of suitable applicants."
6. Cost of call-outs – "The fee for a call-out, if you don't have your own trapper, may be as high as £500 per day, plus travel expenses, and possibly plus subsistence."[4]

UKWOT 'Interventions Spreadsheet'

During the first year of the CL36 licence, UKWOT received 45 enquiries from fisheries; 33 were given fencing advice. Of the 45 fisheries, 23 were fenced and eligible to apply for the licence. 10 had fencing up to the licence standard, 2 had electric fencing, and 3 had an overhang. 6 licence applications were made, 4 led to traps being set. 1 in 4 of the licenced traps led to otters being humanely trapped and removed from the fishery (Table 2).

Otters had entered fenced fisheries in various ways. This included the gate being "left open" (ID 1; ID 36), the fence being "breached" (ID 10; ID 24; ID 38), fence damage due to "vandalism" (ID 11) and "fallen tree" (ID 15), and unknown entrance points (ID 13; ID 44).

[4] In terms of costs, the two Fishery Management Advisors trap as part of their job with the Angling Trust and work under UKWOT policy. If UKWOT trappers need to charge, Embryo Angling covers the costs of the charity.

Vulnerable points were also identified by operatives: "well-fenced but un-gridded culvert allowed entry" (ID 40); "gates, pipes, gate design" (ID 43); "probably got in via a sluice gate (1m diameter pipe) when gate removed overnight due to very heavy rain" (ID 45); and the usual advice of "close the gate behind you".

Enquiries from unfenced fisheries, who cannot apply for licenced trapping, were also insightful. ID 14 "wanted help with cormorants; turned out to have otters too". ID 39 had experienced, "heavy fish loss", they "want to fence … but need planning permission for one stretch and the public are objecting." ID 41 had not stocked fish into this site "since the 1960s", and experienced "predation by 4 otters of fish stocks over the past 6 months".

As Table 3 shows, CL36 enquiries dropped from 45 in the first year of the licence (October 2016 to September 2017) to 6 in the second year (October 2017 to September 2018). 4 of 6 enquires turned into CL36 applications with traps set at 1 site. One of these applications was beyond the CL36: "Otter seen with cable tie caught round its body (on River Stour). About to trap, but otter shook ties off so closed" (ID 46). Traps could have been set legally on welfare grounds but were not required. At the Norfolk fenced fishery where the traps were set, the otter escaped without the need for human intervention: "Otter vanished - probably climbed out over gate before gate modified" (ID 48).

Table 2: UKWOT 'Interventions Spreadsheet', October 2016 to September 2017 – First Year of CL36 Licence

ID	Month	County	Fenced	Fence to Standard	Electric Fence	Overhang	Fence Advice	Licence Applied	Traps Set	Otters Trapped
1	November 2016	Shropshire	Yes	Yes	No	Yes	Yes	Yes	No	<
2	November 2016	Northamptonshire	No	<	<	<	Yes	<	<	<
3	November 2016	Cumbria	No	<	<	<	Yes	<	<	<
4	December 2016	Norfolk	Yes	No	No	No	No	No	<	<
5	January 2017	Gloucestershire	No	<	<	<	Yes	<	<	<
6	January 2017	Lincolnshire	Yes	No	No	No	No	No	<	<
7	January 2017	Worcestershire	No	<	<	<	Yes	<	<	<
8	January 2017	Yorkshire	No	<	<	<	Yes	<	<	<
9	January 2017	Dorset	Yes	No	No	No	Yes	No	<	<
10	January 2017	Oxfordshire	Yes	Yes	No	No	Yes	No	<	<
11	February 2017	Lancashire	Yes	Yes	Yes	No	Yes	No	<	<
12	February 2017	Derbyshire	No	<	<	<	Yes	<	<	<
13	February 2017	Manchester	Yes	No	No	No	Yes	No	<	<
14	February 2017	Lancashire	No	<	<	<	Yes	<	<	<
15	March 2017	Yorkshire	Yes	Yes	No	No	Yes	Yes	No	<
16	March 2017	Devon	No	<	<	<	Yes	<	<	<
17	March 2017	Cheshire	No	<	<	<	No	<	<	<
18	March 2017	Lancashire	No	<	<	<	Yes	<	<	<
19	March 2017	Lancashire	Yes	No	No	No	No	No	<	<
20	March 2017	Monmouthshire	Yes	No	No	No	No	No	<	<
21	March 2017	Leicestershire	No	<	<	<	Yes	<	<	<
22	March 2017	Nottinghamshire	Yes	No	No	No	No	No	<	<
23	March 2017	Yorkshire	No	<	<	<	Yes	<	<	<
24	March 2017	Northamptonshire	Yes	Yes	No	No	No	No	<	<
25	April 2017	Nottinghamshire	Yes	Yes	No	No	No	No	<	<
26	April 2017	Durham	No	<	<	<	Yes	<	<	<
27	April 2017	Shropshire	No	<	<	<	Yes	<	<	<

28	April 2017	Shropshire	Yes	No	No	No	Yes	No	<	<
29	April 2017	Leicestershire	No	<	<	<	Yes	<	<	<
30	April 2017	Leicestershire	No	<	<	<	Yes	<	<	<
31	April 2017	Derbyshire	No	<	<	<	Yes	<	<	<
32	April 2017	Lincolnshire	No	<	<	<	No	<	<	<
33	April 2017	Lincolnshire	Yes	No	No	No	Yes	No	<	<
34	April 2017	Lincolnshire	No	<	<	<	Yes	<	<	<
35	May 2017	Lancashire	Yes	No	No	No	Yes	No	<	<
36	May 2017	Cambridgeshire	Yes	No	No	No	No	Yes	Yes	0
37	May 2017	Lancashire	No	<	<	<	Yes	<	<	<
38	May 2017	Lancashire	Yes	Yes	No	Yes	Yes	Yes	Yes	2
39	May 2017	Oxfordshire	No	<	<	<	Yes	<	<	<
40	June 2017	Lancashire	Yes	Yes	No	No	No	No	<	<
41	July 2017	Cumbria	No	<	<	<	Yes	<	<	<
42	July 2017	Shropshire	Yes	Yes	Yes	No	Yes	No	<	<
43	August 2017	Yorkshire	Yes	No	No	No	No	No	<	<
44	September 2017	Bedfordshire	Yes	No	No	No	Yes	Yes	Yes	0
45	September 2017	Lancashire	Yes	Yes	No	Yes	Yes	Yes	Yes	0
			23 of 45	10 of 23	2 of 23	3 of 23	33 of 45	6 of 23	4 of 6	2 from 4

Table 3: UKWOT 'Interventions Spreadsheet', October 2017 to September 2018 – Second Year of CL36 Licence

ID	Month	County	Fenced	Fence to Standard	Electric Fence	Overhang	Fence Advice	Licence Applied	Traps Set	Otters Trapped
46	November 2017	Dorset	No	No	No	No	No	Yes	No	<
47	December 2017	Lancashire	No	No	No	No	Yes	No	<	<
48	December 2017	Norfolk	Yes	Yes	No	Yes	Yes	Yes	Yes	0
49	January 2018	Durham	Yes	No	Yes	Yes	Yes	No	<	<
50	February 2018	Lincolnshire	Yes	No	Yes	No	Yes	Yes	No	<
51	March 2018	Bedfordshire	Yes	No	No	No	Yes	Yes	No	<
			4 of 6	1 of 6	2 of 6	2 of 6	5 of 6	4 of 6	1 of 4	0 from 1

In the third year of the licence (October 2018 to June 2019), there have been 7 enquiries so far (Table 4); 3 of the 7 became licence applications, traps were set at 2 sites and no otters were trapped. The owner of the Northamptonshire fenced fishery claimed an otter had "killed 20 carp up to 50lb weight, totalling 600lb, £70K loss. Also five dead swans found." Traps were set, "fencing improved and pipes and culverts gridded." There has been, "No otter incursion since then, but a dead carp put in an adjacent reserve was eaten by a large otter seen on camera." At the Oxfordshire fishery (ID 58), the "Otter got in via weak section of fence at inlet where sluice broken" and was "Secured with heavy stone and concrete."

Table 4: UKWOT 'Interventions Spreadsheet', October 2018 to June 2019 – Third Year of CL36 Licence

ID	Month	County	Fenced	Fence to Standard	Electric Fence	Overhand	Fence Advice	Licence Applied	Traps Set	Otter Trapped
52	November 2018	Gloucestershire	Yes	No	No	No	Yes	No	<	<
53	December 2018	Shropshire	Yes	No	No	No	No	No	<	<

54	January 2019	Nottinghamshire	Yes	No	Yes	No	Yes	No	<	<
55	January 2019	Oxfordshire	Yes	Yes	No	No	Yes	Yes	No	<
56	March 2019	Devon	Yes	Yes	No	Yes	Yes	No	<	<
57	April 2019	Northamptonshire	Yes	Yes	No	Yes	Yes	Yes	Yes	0
58	May 2019	Oxfordshire	Yes	Yes	No	No	Yes	Yes	Yes	0
			7 of 7	4 of 7	1 of 7	2 of 7	6 of 7	3 of 7	2 of 3	0 from 2

Overall, of the 58 CL36 enquiries between October 2016 and June 2019, UKWOT recorded 13 CL36 applications, set humane traps at 7 locations and trapped 2 otters at one site. 45 of 58 (77.5%) enquiries led to knowledge exchange about otter-proof fencing.

Angling Trust FMA 'Otter Log'

Between April 3 2017 and March 31 2019 the Angling Trust received 641 otter-related enquiries: 256 in 2017 (March-December), 276 in 2018 (January-December) and 109 in 2019 (January-March). Of the 641 records, 213 enquiries were connected to AIF applications with reference to otter-proof fencing (Table 5). Engagement included: 8 forums; 37 group meetings; 205 site visits; 391 telephone or email enquiries. A search for "CL36 queries" and "trap" in the otter log generated 16 and 79 enquiries respectively.

Table 5: Total otter-related enquiries including advice on AIF ( ) to the Angling Trust (AT FMA Otter Log, 2019)

	January	February	March	April	May	June	July	August	September	October	November	December	Total
2017	-	-	-	40 (9)	23 (12)	28 (15)	24 (6)	14 (10)	41 (12)	30 (4)	39 (19)	17 (5)	256 (92)
2018	48 (15)	20 (3)	38 (19)	42 (21)	22 (13)	24 (12)	8 (5)	12 (6)	7 (1)	13 (2)	23 (2)	19 (2)	276 (101)
2019	47 (6)	34 (8)	28 (6)	-	-	-	-	-	-	-	-	-	109 (20)

Trapped otters

The trapping and removal of otters from fenced fisheries in England is illegal without the registered operatives acting under the CL36 licence. ID 38 contacted the Angling Trust/UKWOT for advice in April 27 2017, a site visit was made, a trapping application submitted to Natural England and approved.

As per licence, the boundary fence of the fishery was inspected by operatives to ascertain how the otter entered the fishery and identify any breaches to the fence which must be rectified. Attempts were then made to flush out the otter. Two seven-feet (220 L x 22 x 25 cm) double-entry traps were then secured within the fishery for just over a week. Traps were covered to make it dark inside, and baited with fish and fresh otter spraints. Once set, the traps were checked at least twice in each 24-hour period by fishery staff, in the morning and in the evening. Remote monitoring devices and cameras were used to notify UKWOT operatives when the trap doors closed.

The first otter was live trapped and released outside the fenced perimeter on May 12 2017, with the traps being left on site for a further week to ensure that no more were present (Figure 2). Two days later on May 14 2017, a second otter was live trapped and released.

Both otters were visually assessed for health following protocol. Neither was harmed or injured as a result of the humane trapping and subsequent release. With no further sightings of otters or signs of otter predation within the fishery, the traps were removed on May 23 2017.

Otters are released immediately outside the fence rather than in another location as they are a protected species and it is important that their territories are not disrupted (Simpson, 2006).

In the press release on May 25 2017, Dave Webb stated: "It is pleasing that the fishery was confident enough to contact UKWOT for help. This is the first live capture of otters under the newly designed licence from Natural England and with our welfare and operating policies in place. The humane trapping and release of two otters from one fenced fishery proves that the licence can be of benefit to both otter conservation and angling. It is without doubt a major step forward for the UKWOT team who worked very hard to get this right, and for ongoing collaboration with fisheries." Daniel Allen added: "It is important to note that UKWOT prefer not to trap otters and only do so to safeguard the welfare of this protected species. Humane trapping is only ever used as a last resort" (Allen, 2017b).

Figure 2: Otter trapped inside Lancashire fenced fishery on May 12 2017

CONCLUSION

The introduction of the CL36 licence has provided a structured legal route to humanely trap otters in fenced fisheries and move them outside the fenced perimeter. With no previous published evidence on the presence of otters in fenced fisheries in England, UKWOT took a pragmatic approach, listening to concerns from those with working knowledge of stillwater fisheries and predation. As a joint initiative between UKWOT and key stakeholders from the angling community, all media coverage underlined the importance of collaboration, and stressed how the licence benefits otter conservation and fenced fisheries. In *BBC Countryfile* magazine, for example, Parr (2016) concluded: "In a world where so many issues become polarized, this is a landmark victory for common sense. For as long as anglers and conservationists can work together and remain proactive, the otter can be a welcome and integral part of our aquatic environment."

In the context of fisheries and predation in England, UKWOT was fully aware of the relatively narrow scope of the licence from the outset, lobbying for the CL36 was always exclusively intended for fenced fisheries as without a formalised legal means to remove otters some fishery managers may have been tempted to illegally kill them to protect their livelihoods. The launch of the CL36 licence generated significant interest from fisheries as demonstrated by the 45 UKWOT enquiries with 6 licence applications in the first year; the fact that 22 CL36 enquiries came from unfenced fisheries suggests there was initially some confusion over the scope of the licence and/or a demand for such a service beyond the scope of the licence. The 6 enquiries with 4 licence applications in the second year and 7 with 3 licence applications so far in the third year suggests the scope of the CL36 licence has become clear.

The UKWOT 'Interventions Spreadsheet' and Angling Trust's 'Otter Log' is evidence of the ongoing concerns about otter predation, and proves that the presence of otters in English fenced fisheries is not as "rare" as expected (OSG UK, 2016), but also not widespread. Natural England (cited in CIEEM, 2017) acknowledged that "demand to register for this new licence and the approved training has been greater than anticipated." This led to a review of the way the licence was operated and the decision "to run further approved training under a more formal contract" (Webb, 2017).

The successful trapping and removal of two otters from a fenced fishery in May 2017 shows the CL36 licence can work in practice and that the protected otter "can be humanely managed in a non-lethal way at a local scale in England" (Allen cited in Allen, 2016), giving fenced "fisheries and anglers alike the confidence that there is a legal, humane and sensible option to help reduce otter predation" (Webb cited in Allen, May 2017).

The Environment Agency and Angling Trust have advised on otter-proof fencing for over a decade (Jay et al, 2008), the CL36 licence has formalised this advice providing standardised fencing specifications for stillwater fisheries (Figure 3).

The CL36 licence has become an important bridge between fisheries, UKWOT and the Angling Trust; and useful access point for knowledge exchange about the effectiveness of otter-proof fencing, need for fencing repairs and improvements, and importance of fence perimeter management. The ongoing dissemination of advice by stakeholders contributes to the prevention of otter predation through collaboration, education and fencing, with humane traps available as a last resort.

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ANNEX B – Otter Fencing Specification

The objective of otter fencing is to provide a robust, physical barrier that the otter can neither climb over nor pass through or under. Otters can pass through gaps of 100mm and an adult otter can easily stretch up to a height of 1m and can climb well.

Guidance is provided below on the specification of fence required to prevent otters from gaining access to a fishery. Please also see the guidance on fencing provided in 'Otters and Stillwater Fisheries'[1]

Fences must be regularly inspected and maintained, including clearance of overhanging and nearby vegetation.

Non-electrified Fence

- The fence should be constructed of material that otters cannot easily bite through, such as a mesh of at least 1.1mm diameter.
- It should be at least 1800mm high if there is no overhang at the top or at least 1200mm if there is a 600mm overhang towards the outside.
- If possible it should be buried 300mm into the ground. At the bottom of the fence on the outside there should be a 'skirt' of at least 900mm of a suitably robust but flexible netting that is securely pinned on the ground. Grass should be allowed to grow up through the netting to help secure it to the ground.
- Fence posts should be tanalised wood or metal with straining posts of 15mm (6 inch) diameter at appropriate distances to support the fence around all angles. All posts must be inside the mesh of the fence.
- The outside of any gates must be covered in sheet metal (e.g. galvanised tin) or the same wire as the fence (and to the same height). The covering must extend to just above the ground and over any hinges or gaps that the otter could use to climb or squeeze through. Gates should be set over a hard-standing or material that cannot be dug.
- Additional protection can be provided by including an electric 'scare wire' attached to the fence posts and positioned so that the otter will touch it and receive a shock if it tries to climb the fence.
  - This should be positioned 50mm below the top of the fence and offset no more than 50mm out from the fence line.
  - A second electric wire may be a useful deterrent in the absence of an overhang. It should be positioned at least 300mm from the ground and if possible 150mm in front of the fencing mesh

Electrified Fence

- Minimum requirement is 1.5 Joule energiser with a fast pulse rate.
- It is essential that vegetation is kept clear of the fence as this will short it
- The fence must be live as soon as it is erected to prevent otters from learning that they can cross it.
- Electric netting must be at least 700mm high
- Electric wire fencing usually comprises at least 3 parallel strands 70, 140 and 210mm from the ground. Four strand fences at 100, 150, 200 and 300mm above ground are also used. The wires must be prevented from touching each other.
  - The wires must be tensioned by a reel post placed at the end of the fence and held by adjustable plastic insulators on metal stakes. Anchor posts should be used for bends and corners.
  - The stakes should be spaced no more than 10m apart; they may need to be closer to cope with undulations in the ground.

Figure 3: CL36 (2016 p. 8) Fencing Specifications

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RÉSUMÉ

EVALUATION DE L'IMPACT DE LA LICENCE DE PIÉGEAGE DE LA LOUTRE EURASIENNE (*Lutra lutra*) DANS LES ÉTANGS DE PÊCHE CLÔTURÉS

La loutre eurasienne (*Lutra lutra*), une espèce en voie de disparition, a été protégée à partir de 1978 en Angleterre et au Pays de Galles. Le rétablissement progressif de l'espèce coincide avec l'augmentation de la capture de poissons dans les étangs de pêche et l'inquiétude grandissante quant à la prédation par la loutre. Bien que la pose de clôture anti-loutre ai été identifiée comme la solution la plus efficace à moyen et à long terme, l'absence de mécanisme juridique formalisé permettant d'éloigner les loutres des étangs de pêche clôturés compromet les possibilités de survie et le bien-être des loutres. Conscient de ce problème, le Wild Otter Trust du Royaume-Uni (UKWOT) a fait pression et obtenu une licence lui permettant de les piéger et de les récupérer avec humanité. Cette publication examine les réponses initiales des médias et des intervenants suite à l'introduction par le Natural England de la «Licence de classe» CL36 permettant de capturer et transporter des loutres eurasiennes (*Lutra lutra*) vivantes des étangs de pêche clôturés afin de prévenir des dommages ultérieurs. La publication analyse la "feuille de calcul des interventions" de l'UKWOT pour les trois années de licence CL36 (de novembre 2016 à juin 2019) et le "Otter Log" de l'AT Fishery Management Advisors (FMA) (de mars 2017 à mars 2019) destiné à répertorier les enquêtes liées à la loutre. Enfin, la publication évalue l'impact du permis dans la pratique, en se référant au piégeage réussi et à l'enlèvement des loutres présentes dans les étangs de pêche clôturés.

RESUMEN

ESQUERÍAS CERCADAS, NUTRIAS EURASIÁTICAS (*Lutra lutra*) Y TRAMPEO AUTORIZADO: UNA EVALUACIÓN DE IMPACTO

La amenazada Nutria Eurasiática (*Lutra lutra*) pasó a ser una especie protegida en Inglaterra y Gales en 1978. La recuperación gradual de la especie coincide con el incremento del "Specimen fishing" en pesquería de aguas quietas y la creciente preocupación respecto de la predación. Aunque el cercado a prueba de nutrias ha sido identificado como la solución de mediano plazo más efectiva, la falta de un mecanismo legal formalizado para remover las nutrias de las pesquerías cercadas comprometía fuentes de trabajo y el bienestar de las nutrias. Reconociendo ésto, el Wild Otter Trust del Reino Unido (UKWOT) gestionó exitosamente una licencia para capturar nutrias humanitariamente y removerlas. Este trabajo examina las respuestas iniciales de los medios informativos y los actores involucrados, a la introducción por parte de Natural England de la Licencia CL36 para captura viva y transporte de nutrias Eurasiáticas (*Lutra lutra*) que son capuradas en pesquerías cercadas para prevenir daños ulteriores. El trabajo analiza el "Formulario de Intervenciones" de UKWOT para los tres años de vigencia de la licencia CL36 (Noviembre 2016 a Junio 2019) y el "Otter Log" de AT Fishery Management Advisors (FMA) (Marzo 2017 a Marzo 2019), para detectar solicitudes o consultas relacionadas con nutrias. Finalmente, el trabajo evalúa el impacto de la licencia en la práctica, con referencia a la captura viva y remoción exitosa de nutrias de pesquerías cercadas.

A R T I C L E

WHAT IS *Lutra paranensis* RENGGER, 1830?

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Abstract: Described from Paraguay, *Lutra paranensis* Rengger, 1830 has long been associated by international authors with the Giant Otter *Pteronura brasiliensis*. However regional South American authors in the early 20th Century applied the name to the Neotropical River Otter *Lontra longicaudis*. The validity of each of these positions is evaluated by comparing the description with both species and the name is found to have been proposed for, and therefore correctly to apply to *L. longicaudis*.

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Keywords: Félix de Azara, *Lontra longicaudis*, Paraguay, Paraná River, *Pteronura brasiliensis*

INTRODUCTION

Johann Rudolph Rengger (1795-1832) was a Swiss doctor, explorer and naturalist who travelled around Argentina, Brazil and Paraguay between the years 1818 and 1826 (Ramella and Perret, 2011). Though he amassed a large collection of flora and fauna (much of which was later confiscated by the Paraguayan government), his principal contribution to the zoological literature was a tome describing the mammals that he encountered, some of these being new for science (Rengger, 1830). A description of his travels was published posthumously (Rengger, 1835), but none of his mammal specimens survived.

Lutra paranensis Rengger, 1830 was coined for Paraguayan specimens of a species of otter which inhabits the Paraguay and Paraná Rivers. Rengger (1830) considered his species to be the same as the "Nutria" of Azara (1801) which was also based on Paraguayan specimens. Rengger's name was treated as valid by regional authors working in the late 19th and early 20th Century (von Ihering, 1893, 1910; Bertoni, 1914, 1939; Werneck, 1937). From the description provided by von Ihering (1893, 1910) these regional authors applied the name to the species now known as the Neotropical River Otter *Lontra longicaudis* (Olfers, 1818).

Usage by European authors of the same period differed however. Nehring (1900) was the first to associate the description of *L. paranensis* with the Giant Otter *Pteronura brasiliensis* (Gmelin, 1788), this being repeated by Pohle (1919) and then, perhaps more significantly, by Cabrera (1957) in his influential catalogue of South American mammals and subsequently by Harris (1968) in his monograph of the otters. The latter three authors applied the name for a southern subspecies: *P. b. paranensis*. From then to the present day the name has been consistently treated as referring to *P. brasiliensis* (Larivière, 1999; Noonan et al. 2017). Indeed some recent authors have continued to recognise *P. b. paranensis* as a valid subspecies for the

southernmost population (Chebez, 2008), albeit sometimes with an expression of doubt (Duplaix, 1980).

A thorough review of Rengger's (1830) text (which includes no illustrations) and comparison with a specimen of *Lontra longicaudis* leaves no doubt that his name refers to that species. My English translations of the original German texts are provided, along with a discussion of the conclusions of Nehring (1900) and the repercussions of the misapplication of this name. I have numbered Rengger's paragraphs for convenient reference in the discussion.

METHODS

The text of Rengger (1830) was compared with modern literature descriptions and anatomical illustrations of *Lontra longicaudis* and *Pteronura brasiliensis*, and a large female specimen of the former from Paraguay housed in the Colección Zoológica de Pilar La Tierra, based at Centro IDEAL, Pilar, Ñeembucú department, Paraguay (CZPLT-M-515; 18 July 2018; 72km E of Pilar, Paraguay; skin and skeleton). No Paraguayan specimens of *Pteronura brasiliensis* were available for examination, although the species is confirmed to occur in the country (Cartes et al., 2013). The results were then compared against the text of Nehring (1900) to examine the validity of the claims therein.

Rengger's text (1830)

Lutrinae

Introduction: Paraguay has only one genus of otter, the first and only description of which we owe to Azara. In his work on mammals of Paraguay, he gives them the systematic name of Mustela lutra brasiliensis, *considering them to be identical to the otters found in Brazil. In fact, there is so much resemblance between the two in form and colour that, without comparing the teeth with each other, one could regard one as only a modification of the other. The Brazilian otter has, according to all descriptions, the same number of teeth as the European; in the case of the Paraguayan, on the other hand, this is not the case, which is why I consider it to be a separate genus and describe it with the name* Lutra paranensis, *swimming in both the Parana and the Paraguay Rivers.* Lutra paraguaensis, *mentioned in some systematic works, does not occur in Paraguay, and must not be confused.*

1) *I was as unsuccessful as Azara in finding out the Guaraní name of this species of otter. In Paraguay, as well as along the Paraná, it is called "Lobo" by the Indians and the Creoles, incorrectly being regarded as a kind of seal, from the Spanish "lobo marino".*

2) *The coat is covered with two types of hair, which are very dense and almost vertical to the skin. The woolly hairs are about six lines long, straight and extremely soft to the touch. The bristle-hairs differ from them only in that they are about one line longer, somewhat stiff, and not quite so soft, and are more shiny in their upper half. Around the mouth and over the eyes are a few, one-and-a-half- to five-inch-long, shiny bristles, and a tuft of similar hair is found behind each corner of the mouth on a kind of wart. The septum of the nostrils, the eyelids and the lower side of the toes and the webs are naked.*

3) *The colour of the whole fur, except the throat, is dark brown and shiny. At the throat there is a large, almost square, bright spot, the color of which differs*

according to the age of the animal. In very young individuals, which still possessed the deciduous teeth, I found them brownish-red in the case of those which had just changed them, and yellowish-white in the case of very mature individuals several years old. It should be noted that in the infants the upper lip is set forward with brownish-red hair, which is replaced by brown at the first moult.

4) *I found no difference in colour between the male and the female. Azara, on the other hand, mentions a white tip to the tail of the latter, a statement that I cannot dismiss, as I have seen only two very young female individuals, which, as is often the case with young animals, could differ from mature females in their colour.*

5) *A large male of this species of otter had the following dimensions:*
5" 6 lines length of head; 1' 8" 8 lines length from the occiput to the root of the tail; 1' 7" length of the tail; 11" around the midsection.

6) *Azara stated that the female has a slightly shorter tail than the male, but this is not the case with very young individuals.*

7) *The difference in the proportions of the body parts to each other between a young and fully grown animal, especially that of the head to the body, may be shown by the following dimensions, which are taken from the skeleton of a specimen of* Lutra paranensis *of approximately four months of age:*
1' 8" 3 lines total length; 3" 9 lines length of the head; 2" 2 lines greatest width of the cranium; 1" 8 lines cranial height; 9" length of the spine to the first caudal vertebra; 7" 6 lines length of the tail; 1" 9 lines length of the upper arm; 1" 11 lines length of forearm; 1" 9 lines length of the front foot; 1" 8 lines length of the thigh; 1" 10 lines length of the leg; 3" length of hindfoot.

8) *Although these otters are similar in their outward forms to the European ones, if one compares them carefully, there is a significant difference between them. The head of the former, is large in proportion to the rest of the body, vertically compressed and wide. The face occupies only a quarter of its length. The rounded muzzle protrudes slightly above the lower jaw. The nostrils are almost completely covered by crescent-shaped valves, the convex margin of which looks down below; Azara compares them to a C with horns pointing upwards. These flaps close the nostrils just as the animal submerges. The eye is small, round, black and shiny, the eye socket is forward-facing. The pinnae are also small, about seven lines wide and high, and with a rounded edge. The muscular neck is of about the same width as the head. The trunk is almost cylindrical, and the broad tail is compressed dorsally and rounded at the end. The four legs are short, but very muscular. The toes are connected by a thick web which leaves the last phalanx free, and even reaches to the nail on the outermost toe. The nails are small but strong, laterally compressed, and hardly bent.*

9) *As for the teeth, the adult has six tightly packed incisors in the upper jaw. The four central incisors are almost of equal size, laterally compressed, wedge-shaped and with a convex cutting edge. The two outer incisors are thicker and slightly longer than the inner ones. They are conical, and curved outwards and backwards, so that, in the direction of the edge of the jaw, they appear bent backward and resemble canine teeth. Separated from them on each side by a small space is a six-line long canine, angled slightly backwards, conical, and curved slightly to the inside, and then four*

molars. Of these, the first has only a blunt, conical spike, which is slightly curved on the inner and the posterior side. The second is very similar to the first one in its form, but it is half as large again. The third, or carnassial tooth (grande carnassière), has on its outer margin three spikes, of which the foremost is small, the two rear ones are strong, and there is a large depression, with a notched margin on the inner edge. On the fourth, which is one-third broader than it is long, two bumped cusps are noted on the outer side, and two inward, both pairs separated by a wide depression. There are also six incisors in the lower jaw, which increase in size from the inside outwards, and, at least when they have just emerged, show a slight elevation in the middle of the cutting edge. The canine teeth are like those of the upper jaw. They are followed by five molars on each side. The first two have the same shape as the two first upper molars; the third likewise has only one cusp, which is compressed at the sides, but ridged at the front and back from the tip to the base; in the middle of the back ridge a very small spike rises vertically. The crown of the fourth molar consists in the front of three spikes, which have the shape of three-sided pyramids and form a triangle, and behind a large depression, which shows some sharp elevations on its outer edge. You also notice a depression on the circular crown of the fifth molar.

10) *The deciduous teeth in each jaw consist of six incisors, two canines and six molars, all of which are very small by comparison with the adult teeth. The incisors and canines deviate only slightly in shape from those that replace them, unlike the molars. The first molar in the upper jaw is small and pointed; the second has the form of a four-sided pyramid, with a strong, curved edge, on the inner side a small step, with a ridge running along the back; the third possesses two lumps and is step-like on the inner side. In the lower jaw, the first molar has the same shape as the first upper molar, the second has a curved rear edge, and the third two triangular edges, which are behind one another, in addition to a small cusp on the inner side of the second edge and a depression on the rear side.*

11) *Both the permanent and the deciduous teeth have larger interior cavities than are found in other predatory animals.*

12) *Taking into account what I have said so far about the otter of Paraguay, it can be said to differ from the Brazilian in the absence of the long white or yellowish stripes on the lower part of the neck, in the absence of the reddish-yellow spot on the breast, and, at least according to Azara, by the white tail tip of the adult female; furthermore, there are only four molars on each side of the upper jaw, while the latter has five. Finally, it never seems to me to reach the size of the Brazilian species, as I have not seen any individual that has a total length of four feet.*

13) *This otter is common in Paraguay along the two great rivers, the Paraná and Paraguay, but is found more rarely on the tributaries which flow from the interior of the country into those waterways. How far to the south of this it occurs I do not know; however, it is said to have been found on the Paraná as far as 29ºS latitude.*

14) *The otter lives partly on land and partly in the water. It spends the night on land and a few hours during the day to sleep, or when it needs a rest. It also goes ashore to eat. Sometimes it will take overland excursions and visits marshes and small lakes close to the place of residence. The rest of the time it stays in the water and hunts for its food, which consists of fish alone. It swims faster and lighter than our European*

otter, which may well be due to the broad tail, and is able to spend longer under water; the head is usually submerged and rarely rises above the water when it floats over large distances.

15) *Incidentally, the way of life is not the same all year round. After the mating season, which is in the months of July and August, that is to say in the Paraguayan winter, it lives in pairs, and remains in a territory until the litter is grown. Afterwards the female seeks a steep bank on the river or lake she inhabits, and there digs a four to five foot deep den, the mouth of which is one and a half to two feet in diameter. Here, the pair regularly spend the night and in cool weather, they sun themselves by day in front of the entrance. In spring the female gives birth to two or three young, and together with the male, they raise the brood with fish. Sometimes, at this time of the year, the rising waters may threaten the young litter, so the adults dig a new den higher up the shore, and bring their young to safety. As soon as they are able to crawl on land, the juveniles follow the mother into the water and pursue fish. The whole family returns to the den each night, and from time to time throughout the day. This behaviour continues until mid- summer, at which time the otters unite into groups of eight to ten, or twenty individuals. At this time they never spend long in the same area, and will swim for whole days upstream, penetrating well into the smaller streams and into lakes. This happens especially in autumn, when the waters are high and most fish leave the Paraná and the Paraguay rivers and enter flooded areas, where they find abundant food. Also on these migrations, the otters ascend to the land during the day, whether to consume their prey or to rest, and at night, to sleep. It is not uncommon for them to fight, giving a scream that is not unlike that of cats but much louder.*

16) *During the hunt on the Paraguay River, I had several opportunities to observe closely such common groups of otters nearby. Soon these animals, either with their snouts or with their whole heads, appeared on the surface of the water, snarling and snorting, and expelling the water which had penetrated into the nostrils. Immediately however, they submerged again and rose again far away, where I lost sight of them. From the water surface, they submerged in two ways, either sinking straight down or, diving with their backs raised above the water. Not infrequently, they held a wriggling fish in the mouth when they reappeared, and they immediately swam ashore to consume it, including the head and the bones. These predatory animals take not only small fishes, but also larger ones, two or more feet long.*

17) *As these otters are seldom pursued by humans, they are curious and not shy, and even closely approach boats, often rising out of the water with half of their bodies.*

18) *Azara's information on the wild behaviour of the species is based on the testimony of the Payaguas. That several females rear their cubs in the same den, and that males and females spend the night there throughout the year is quite incorrect. I do not understand how he could attach such faith to the testimony of these people, since he, like everyone else in Paraguay, must know them as the most lewd and mischievous of all the Indians. However, I can confirm Azara's own observations, that he made on a tame otter. Mine was a male, and when I received it, it was about two months old. During the first two weeks of its captivity it was stubborn and bit when I tried to touch it; however, it did not hesitate to consume its food in the presence of a human being. I raised it with fish, raw meat, milk and water. Gradually it became so tame, that after*

two months it ran free without trying to escape. It played with its guard, as well as with cats and dogs, obeyed his call and followed him in the house. It harmed neither the poultry nor the other domestic animals. When it was freed it usually first visited the water tank located in a corner of the courtyard and bathed there for some time. If a live fish was thrown into the container, it caught it at once and immediately left the water to consume its prey on land. Several times I took the caught fish from its mouth without bother, and threw it into the container; but no sooner did I do this then it had taken the fish out again. Unfortunately, this tame animal would later be trampled on by a horse, otherwise I would have made an attempt to train it to fish in the River Paraguay, which as a result of the cooperative character that it had hitherto shown, I have no doubt would have been successful.

19) *This otter slept curled up at night, and at midday; the rest of the time it was awake, but, unlike other predatory animals, without moving much on the leash to which it was tethered. Even when untied; it walked only briefly around the yard, and soon sought out a man or a pet, beside whom it would lie down. The usual gait was a slow step; sometimes jumping in series. In general the movements on land were neither agile nor swift. It was only vocal when angered by mistreatment. It was a unique shriek, comparable to the wail of a cat. Like most predators, it loved cleanliness, and usually deposited its excrement in the same place. In the water it abstained from defecating and always got out of the container first. It did not have an unpleasant odour, unlike the European species.*

20) *In Paraguay the meat of the otter is considered unpalatable by both the Indians and the Creoles. Freshly fried or boiled, it has no pleasant taste; but if it is first pickled and then prepared, then it can be eaten. Neither is the coat used, though the quality of it would be appreciated in Europe. As this species of animal is of no use to the inhabitants and does no harm to them, it lives undisturbed by man in the waterways of Paraguay.*

2)1 *If one seeks to hunt the species, it is best to do so during the mating period, waiting in the vicinity of the den. At this time it is not difficult to kill the animal as it comes ashore, but if one follows the otters in the water, though it may be easy to fire a deadly shot, the body is extremely difficult to retrieve as wounded animals remain submerged and no longer come into view. Only once did I catch an otter away from the water; the dog which I brought with me immediately attacked it, but was met with obstinate resistance, the animal bravely defending itself with its teeth, whilst at the same time making screeching noises; it would probably have reached the safe refuge of the water again if I had not had my dog for help.*

22) *Among the mammals the otter has only the jaguar as an enemy, which takes it at night when it is resting on the shore. In the water, however, there is another, equally terrible, enemy a great water-snake, which belongs to the genus* Erix (author note - probably in reference to a species of *Eunectes*). *I found a near adult otter in the stomach of an eighteen foot long snake of this type.*

DISCUSSION

The opening line of Rengger's (1830) introduction and descriptive text indicates that he considered his otter to be the same species as Azara's (1801) "Nutria" (the only species of otter cited in that work). Rengger clearly was under the impression

that Azara was discussing a Paraguayan form of *Pteronura brasiliensis* (surmised from his reference to it as "The Brazilian"), and this was not an unreasonable assumption given that Cuvier had attached the name *Mustela lutra brasiliensis* to the description in the French translation of the work (the first version of Azara's tome to appear in print). Azara's original Spanish text was printed later (Azara, 1802) but the author himself did not employ any Linnean names. The description of Azara's (1801) "Nutria" is, however, conclusively a Neotropical River Otter *Lontra longicaudis* based on the measurements provided (Table 1), the description of the pelage, the extremities of the toes free from webbing, the naked nose and the broad-based, pointed tail. However the ecological data he provides, information derived in part from the Payagua indigenous peoples of the Paraguay River, certainly refer in part to *Pteronura brasiliensis*.

Table 1. External measurements for male specimens and female specimen CZPLT-M-515.

	Large male *Luta paranensis* of Rennger (1830)	Azara's "Nutria" (1801)	*Lontra longicaudis*	*Lontra longicaudis* CZPLT-M-515	*Pteronura brasiliensis*
Length of head	140.26 mm	N/A	Skull 94-120 mm	148 mm	Skull 155.5-175 mm
Length of ear	"Approximately" 15.47 mm	12.70 mm	18-22 mm (Larivière, 1999)	15 x 19 mm	22 mm (Noonan et al., 2017)
Length of head and body	661.14 mm	617.22 mm	500-790 mm	570 mm	960-1230 mm
Length of tail	477.80 mm	457.20 mm	375-570 mm	460 mm	450-650 mm
Guard hair length	15.46 mm	15.47 mm	14 mm	13-15 mm	8 mm
Length of upper canine	13.26 mm	15.47 mm	NA	14 mm	21 mm (de Oliveira et al., 2007)
Total length	1138.94 mm	1074.42 mm	900-1360 mm	1030 mm	1450-1800 mm

An inch is interpreted as 25.4 mm, a line is interpreted as 2.21 mm as per the conventions of the early 19th Century (Azara, 1801; Smith et al., 2018). Measurements for *L. longicaudis* and *P. brasiliensis* taken from Foster-Turley et al. (1990) unless otherwise stated.

Rengger (1830) distinguishes *Lutra paranensis* from "the Brazilian" (i.e. *Pteronura brasiliensis*) in his text by the "the absence of the long white or yellowish stripes on the lower part of the neck" (Paragraph 12). It should be noted that whilst the neck markings on the throat of *P. brasiliensis* are individually variable, and very occasionally even absent (Groenendijk et al., 2014), Rengger's statement that the species is common along the Paraguay and Paraná Rivers makes it questionable whether such variation could credibly account for the absence of mention of the classic throat markings in the description. Furthermore, the statement that he has "not seen any individual that has a total length of four feet", realistically excludes *Pteronura brasiliensis*, in which even the smallest adults habitually exceed that length. Indeed Rengger's measurements of his "large male" are remarkably consistent with those of Azara's (who also measured his "largest" specimen), and both are of standard length for adult *Lontra longicaudis* (Table 1).

Nehring (1900) first proposed that *Lutra paranensis* was *Pteronura brasiliensis*, providing a rather selective case based largely on his own comparison of the description with a captive specimen of that species in the Berlin Zoological Gardens.

He justifies the selectivity by invoking the idea that Rengger lost many of his specimens and thus his description (written later in Switzerland) may be considered only partly reliable (a thought process later echoed by Pohle (1919)). This is somewhat true, and there are elements of his description that suggest it is partly composite, but it is possible to mitigate this effect by examining the level of detail provided in the different parts of the description. It would seem reasonable for example that a high level of detail or the provision of measurements in the description of characters would be reflective of greater accuracy and not memory, whilst limited or vague description might theoretically be of questionable reliability, or even inaccurate; however, such an approach is subjective and open to dispute. As if to demonstrate this, Nehring (1900) cherry-picks the characters consistent with the specimen of *Pteronura* he had at hand, and contrives rejection of anything that is inconsistent with it as an artefact of Rennger's allegedly faulty memory. Notably the author makes no direct comparison of the description with specimens of *Lontra longicaudis*.

For the most part Rennger's (1830) description of the animal is extremely detailled and, if taken to apply to *L. longicaudis*, accurate; Nehring (1900) does the author a disservice by implying that such significant portions of the description are embellished or erroneous. Below I discuss the strength of Nehring's arguments.

Size (Paragraphs 5 and 12): Nehring (1900) notes the significant difference in size between *L. paranensis* and *P. brasiliensis*, but adds that that the measurements for Rengger's (1830) "large male" are comparable to the size of his female *P. brasiliensis*, an inconsistency that he explains away as potentially a product of immaturity of the male. However, Rengger specifically refered to this specimen as a large male, there being no obvious need to do so unless this was in fact true. Rengger's (1830) measurements are also, importantly, perfectly consistent with a large male *Lontra longicaudis* (Table 1).

Face (Paragraph 8): Nehring's (1900) claim that Rengger's statement that "the face occupies only a quarter" of the head is consistent with *Pteronura* is not borne out by skulls (assuming for the sake of argument that measurement of the "face" is from the tip of the snout to the zygomatic process). In fact the face of *Pteronura* occupies a significantly greater portion of the head than it does in *Lontra*, representing approximately a third of the skull in the former, and much closer to a quarter in the latter. In a skin specimen of *Lontra longicaudis* (CZPLT-M-515) the "face" (measured externally from the tip of the snout to the posterior border of the eye) was 38 mm, whilst the head length (tip of the snout to the occiput) was 148 mm: this gives a ratio extremely close to a quarter.

Feet (Paragraph 8): Nehring (1900) simply states that the description of the webbing is consistent with *Pteronura*, but offers no further discussion. In fact this is untrue. Rengger states: "*The toes are connected by a thick web which leaves the last phalanx free, and even reaches to the nail on the outermost toe*". In *Pteronura* the webbing is complete and reaches the base of the nail between all toes, whilst the webbing in the three Paraguayan specimens of *Lontra longicaudis* examined is consistent with Rengger's description. Nor is there any reference in Rengger to the conspicuously "oversized" feet of *Pteronura.* Although the claws are described as "hardly bent", this does not mean that the claws are not bent at all and the extent of bending can only be guessed at because Rennger does not clarify with what kind of bent claw he is comparing his otter. Certainly, compared with the claws of certain felines with which

the present author is familiar, the claws of *L. longicaudis* may be understood to be "hardly bent".

Pelage (Paragraph 2): Nehring (1900) claims that Rengger's description of the texture of the coat is consistent with *Pteronura* but provides no supporting data. However *Pteronura* is described in the modern literature as having the fur composed mainly of short, velvety guard hairs of approximately 8 mm length and virtually no underfur (Ihering, 1893; Foster-Turley et al., 1990; Carter and Rosas, 1997). Rengger makes specific reference to a woolly underfur of 6 lines (13.25 mm) in length, with bristled guard hairs one line longer (15.46 mm). The pelage of *Lontra longicaudis* has guard fur length of approximately 14 mm and abundant underfur, this being consistent with that of the description of Rengger (Table 1).

Nose (Paragraph 8): Images of the rhinarium of *Lontra longicaudis* and *Pteronura brasiliensis* are provided by Foster-Turley et al. (1990) on pages 101 and 112 respectively. The description of the shape of the nostrils and valves is clearly consistent with that of *L. longicaudis*. Furthermore a naked septum is present in Paraguayan *Lontra longicaudis* (Figure 1), with *Pteronura* notable for its fully-furred nose (Ihering, 1893; Noonan et al., 2017). In order to explain away this inconsistency with *Pteronura* Nehring (1900) suggested that Rengger's captive animal may have rubbed its own nose bare whilst living in his apartment (Nehring, 1900), whereas Pohle (1919) arbitrarily elected to put this down to Rengger's by now infamous failing memory. The same supposition was repeated by Harris (1968). All authors ignored the fact that Azara (1801) also described the same bare nose for his "Nutria".

Figure 1. Muzzle of Paraguayan specimen CZPLT-M-515 showing naked septum.

Ear (Paragraph 8): Rengger described the ear pinna of his specimen as having a rounded edge. Though the ears of *Pteronura* are more rounded than those of *L. longicaudis* (which are commonly referred to as "pointed"), both species have a rounded edge to the pinna (Figure 2).

Molars (Paragraph 9): Nehring (1900) was of the opinion that more data were required in order to evaluate the importance of the number of molars reported by

Rengger, adding that his female *Pteronura* possessed four upper molars. In fact the first premolar is extremely small in both species, being situated on the internal side of the canine where it is not visible externally, and indeed is sometimes even absent (Ihering, 1910; Husson, 1978). There is no diagnostic value in the number of molars. Both *Pteronura* and *Lontra longicaudis* share the same dental formula of i3/3, c1/1, p4/3, m1/2 = 36 (Larivière, 1999, Noonan et al., 2017).

Figure 2. Ear of Paraguayan specimen CZPLT-M-515 showing rounded edge.

Tail (Paragraphs 8 and 14): The crux of Nehring's argument rests on the description of the flattened tail and rounded shape to its tail tip, to which he affords great weight. It is true that the description of a compressed, broad tail with rounded end is more consistent with *Pteronura* than *Lontra.* The tail of *Lontra* is more cylindrical (though somewhat flattened), broad at the base and tapers to a point. What is notable about the reference to the tail however is the lack of detail Rengger provides on what might be considered to be an important diagnostic character. Notable too is the omission of mention of the ridged edges of the tail present in *Pteronura* (Gray, 1868). If one were to look for circumstancial indications of text that may have been added from memory as Nehring infers, then this would arguably be a case where the level of precision is inconsistent with that of the rest of the text.

Comparison with Lutra lutra (Paragraph 8): Rengger (1830) notes the similarity of his animals to the Eurasian Otter *Lutra lutra* (Linnaeus, 1758). The much larger and quite differently-shaped *P. brasiliensis* cannot be said to invoke any such similarity.

Omissions: There is no mention in the texts of Azara or Rengger of the conspicuous tufts of hair on the ankles of *Pteronura brasiliensis*, a character that is absent in *Lontra longicaudis* (Gray, 1868; Noonan et al., 2017).

Ecology (Paragraphs 14-22)*:* The description of the ecology of the species is consistent in some key characters with *Pteronura brasiliensis*, most notably the description of sociality, reproduction and the den. It seems likely that this section of the description is composite, but as the type series of *L. paranensis* includes all the

specimens referred to by the author, including those of Azara (Art. 72.4.1; ICZN International Code of Zoological Nomenclature), and all of the described specimens are identifiable as *L. longicaudis*, there is little to be gained in nomenclatural terms by speculating on the possible composite nature of observed behaviours, especially when these originated in most cases from unknown sources. The possible composite nature of this part of the description is of little consequence.

CONCLUSION

L. paranensis Rengger, 1830 was considered the valid name for the smaller otter species inhabiting the Paraguay and Paraná river basins at the turn of the 19th to 20th centuries by Bertoni (1914, 1939) and Ihering (1893, 1910). It was employed because of its priority over *Lutra platensis* Waterhouse, 1838: 21, another name which had been applied earlier to the same taxon in the most influential works of the 19th Century (Hensel, 1872: 87; Burmeister, 1879: 166; Cope, 1889: 141; Thomas, 1889: 199; Forsyth Major, 1897: 137; Trouessart, 1897: 286). There was in fact much debate over the specific limits within the genus at this time, complicated by an abundance of available names, a scarcity of specimens, and general morphological conservatism amongst otters coupled with great individual variation. Scientific names published in Olfers (1818) (including *Lutra longicaudis*) had until that point been overlooked, but were later listed and validated by Hershkovitz (1959). By the time this work was published however *L. paranensis* was already being widely misapplied to *Pteronura brasiliensis*.

The decision by Cabrera (1957) to follow Pohle (1919) in attaching the name *paranensis* to a supposed southern subspecies of *Pteronura brasiliensis* (with a restricted type locality of "Rio Paraná") was perhaps most influential in cementing the incorrect usage. This is unfortunate given that no type specimen(s) survived for the taxon. Nor did Harris (1968), in a key work on the Lutrinae, question the conclusions of Nehring (1900) and Pohle (1919).

Today *Pteronura brasiliensis* is generally considered monotypic (Noonan et al. 2017), though the name *paranensis* has still been occasionally employed for southern populations (Duplaix, 1980; Chebez, 2008). Genetics do not however support any such subspecific separation (García et al., 2007). Furthermore, even if Rengger's description could be fitted to a species of *Pteronura*, the degree of difference described by Rengger (1830) would be at the specific, and not the subspecific level. There is no doubt however that *Lutra paranensis* Rengger, 1830 when correctly applied, is a junior synonym of *Lontra longicaudis longicaudis* Olfers, 1818 and is available for application to that taxon. Given the clarity of this case I consider it would be not valid to declare a neotype (under Articles 75.1 and 75.3 of the ICZN (1999) International Code of Zoological Nomenclature): there is no ambiguity to be dispelled, merely a longstanding mistake in application to be corrected.

As an additional observation *Lutra paraguaensis* Schinz, 1821: 213, which was described as "Otter aus Paraguai" has also been placed in the synonymy of *Pteronura brasiliensis* since Thomas (1889) and Pohle (1919). Schinz (1831) includes *Lutra brasiliensis* in his work, and lists *L. paraguaensis* separately with the following brief description:

"*Kleiner als der vorige, Pelz dunkel weich und glänzend. En Paraguai und am Plata Flusse*". (Smaller than the previous species. Fur dark, soft and shiny. In the Rivers Paraguay and Plate).

The previous species with which the "Otter aus Paraguai" is compared, and said to be smaller than, is "Wolfsotter" *Lutra lupina*. That species is described confusingly

as “as large as a pointer (Hühnerhund)” and was also placed in the synonymy of *P. brasiliensis* by Thomas (1889) and Pohle (1919). Regardless of the vagaries of the description, an animal that is smaller than a Pointer dog is also smaller than an adult *Pteronura brasiliensis*. Furthermore the only otter species that shows the distribution provided of the Rivers Plate and Paraguay is *Lontra longicaudis* (Hunter and Barrett, 2011). No type of *L. paraguaensis* exists to my knowledge, and the description is obviously deficient. However whilst the description is inconsistent with *P. brasiliensis* it is broadly consistent with *L. longicaudis*, and it thus probably belongs in the synonymy of the latter.

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RÉSUMÉ\ : QUI EST *Lutra paranensis* RENGGER, 1830?

Décrit au Paraguay, *Lutra paranensis* Rengger, 1830 a longtemps été associée par des auteurs internationaux à la loutre géante *Pteronura brasiliensis*. Cependant, au début du XXe siècle, des auteurs régionaux sud-américains appliquèrent ce nom à la loutre à longue queue, *Lontra longicaudis*. La validité de chacune de ces positions a été évaluée en comparant la description des deux espèces et il s'avère en conséquence que le nom proposé, à savoir *L. longicaudis*, est correctement utilisé.

RESUMEN: **¿QUÉ ES *Lutra paranensis* RENGGER, 1830?**

Descrito de Paraguay, *Lutra paranensis* Rengger, 1830 ha sido por mucho tiempo asociado por autores internacionales con la Nutria Gigante *Pteronura brasiliensis*. No obstante, autores Sudamericanos trabajando en los primeros años del Siglo 20 aplicaban el nombre al Lobito del Rio *Lontra longicaudis*. Se examina la validez de ambas posiciones comparando la descripción con ambas especies, con la conclusión que la aplicacion correcta se refiere a *L. longicaudis*. Se declara un neotipo Paraguayo para *L. paranensis*, para fijar su utilización.

O S G M E M B E R N E W S

New Members of OSG

Since the last issue, we have welcomed 10 new members to the OSG, and welcomed back a former member: you can read more about them on the Members-Only pages.

Zahid Amin, Bangladesh: I have been working with smooth-coated and Eurasian otters for four years on various projects. We are currently working to develop animated cartoons in Bangla to generate awareness of otters, as well as monitoring otter status, population and threats in 10 regions of Bangladesh.

Ruchi Badola, India: I am a Professor, and head of the Department of Ecodevelopment Planning & Participatory Management at the Wildlife Institute of India. My interests are in the human dimension in conservation, ecological economics and gender issues in natural resource management.

Jessa Belle Garibay, Phillippines: I am the Co-Executive Director and Co-Founder of Centre for Sustainability PH, a women-led, youth, environmental non-profit here in Palawan, The Philippines. Our mission is to conserve Palawan's last remaining virgin forests through the legal establishment of protected areas thereby securing resources and habitats for both humans and wildlife. Our biggest achievement so far has been the legal establishment of Cleopatra's Needle Critical Habitat (CNCH), now the Philippines' biggest Critical Habitat, representing 41,350 hectares of virgin forest. Cleopatra's Needle is the highest peak and largest drainage basin of our City, the ancestral domain of the last 200 members of the disappearing Batak tribe, and home to countless endemic flora and fauna, including the ASCO.

Christian Hildebrandt, Germany: My Master's thesis is on "Otter Protection in Traffic in Thuringia", usding GIS to determine the ecological passability of bridges and their effect on the biotope network for otters. I am also involved in a follow-on project conducting a behavioral study of otters under bridges to recommend improvements so that more otters use the safe way under the bridges and fewer die on the roads.

Kilian Hughes, India: I work at Wild Otters in Goa, studying the adaptation, habitat selection, behavior and distribution of the Smooth-coated otter across Chorao island, which is a human dominated/modified landscape

Danelle and Brendan Murray, South Africa: Brendan and I are the founders of Owl Rescue Centre, a Non Profit Organisation based in the North West Province of South Africa which is concerned with the protection and wellbeing of all owl species, wildlife and biodiversity. We were asked to rewild, release and post release monitor a very tame five year old African Clawless Otter, Lazarus, who had been rescued as a cub but remained in captivity. Specific challenges included 1) to overcome his fear for water, 2) to facilitate the process that would allow the otter to adopt crucial survival skills and 3) to break human contact and encourage independence. Release was successful, and we continue to monitor him.

Clara Ortiz-Alvarez, Peru: I have done several projects surveying for Marine Otters in various regions of Peru . I plan to continue working with marine otters, and collaborate with other Peruvian researchers to gain a clearer pictrure of the Lontra felina population.

Indranee Roopsind, Guyana: I was a member of OSG for ten years, but then stopped working with otters. Now I'm back! I'm working with Giant Otters in the North Rupununi on habitat use and behaviour

Karin Schwartz, USA: I am a long-standing zoo professional with extensive experience in data management as applied to conservation nationally and internationally. My Ph.D. research was on linking in situ and ex situ data management processes for endangered species recovery programs through the Species360 Zoological Information Management System. As Registrar at the Milwaukee County Zoo, I led the development of and was Co-Administrator the AZA Institutional Records-Keeping Course for 20 years. I also have international records training experience for zoo associations in Argentina, India, and South Korea. I am an active member of IUCN Conservation Planning, Conservation Translocation, and Tapir Specialist Groups and now work for WildTrack to coordinate the participation of zoos in developing algorithms for Footprint Identification Technology (FIT).

Hannah Slaney, United Kingdom: I am deputy head of the tiger section at Colchester Zoo. In this role I work with a group of smooth coated otters, I have been working with this group for 4 years and am involved in all areas of their care. My future plan is to complete the best practice guidelines.

OSG MEMBER AWARDS

SIR PETER SCOTT AWARD FOR CONSERVATION MERIT

Nicole Duplaix, Co-Chair of the IUCN Otter Specialist Group, received the Sir Peter Scott Award for Conservation Merit in recognition of her significant and 50-year service to global conservation through her work to conserve biodiversity, and most especially her extraordinary efforts to conserve the thirteen species of otters throughout the world. The award was presented in October 2019 by the IUCN Species Survival Commission, at the Leaders Meeting in Abu Dhabi. The award cites Nicole's "constantly enthusiastic, positive and encouraging personality that that enabled to help countless conservationists worldwide." The Sir Peter Scott Award, named after the first Chair of the SSC, is the most prestigious award by the Commission; previous awardees include Dr. Russ Mittermeier and Dr. Simon Stuart. Her vision, energy, commitment, deep knowledge of the otter family, and constructive support of young researchers and conservationists the world over has made her the hero of the otter world, and earned her our affectionate title of "Mama Otter." Congratulations Nicole, from otter lovers everywhere.

SAWMA WILDLIFE EXCELLENCE AWARD WINNER 2019

Dr. Dave Rowe-Rowe was born in Queenstown in the Eastern Cape in 1938. After growing up in both the rural Eastern Cape and Botswana, Dave matriculated from Port Shepstone High School (KZN) in 1956 and initially trained as a biology teacher, qualifying in 1959. Perhaps it was the trauma of having to teach teenage kids, but in 1966 Dave joined the scientific staff of the then Natal Parks Board and later gained entrance (without having completed a prior degree) into the University of Natal, Durban to undertake a Master's degree. He demonstrated rather nicely that the decision to let him register for a Master's was fully justified by graduating (with distinction) in 1976. His thesis covered aspects of the biology of several southern African mustelids, work which he continued throughout his career and for which he is probably best known. Dave was awarded his PhD on the ecology of several mammals in the Drakensberg in 1983 (whilst still working for the Parks Board).

Apart from spending 30 years in the service of the Natal Parks Board (now Ezemvelo KZN Wildlife) where he was at the coalface of wildlife management in South Africa,

Dave was also one of the founding members of SAWMA in 1970. In fact, Dave is one of the very few life members of SAWMA and has been since 1971. Moreover, Dave served as SAWMA's journal editor between 1986 and 1993, a tenure of 7 years which makes him the longest serving editor in the association's history.

Dave not only served as editor for SAWMA but also for several other important publications, including:

- the Lammergeyer (the Natal Parks Board Journal) for 10 years;
- the Natal Parks Board leaflet series: Wildlife Management Technical Guides;
- the IUCN/SSC Otter Specialist Group Bulletin for 4 years;
- Proceedings of the Sixth International Otter Colloquium.

Before he retired, Dave was responsible for research on a broad range of species and ecosystem processes including freshwater fish, antelope, small mammals, aspects of fire ecology, habitat management and carnivore ecology. This diverse suite of study animals and systems is evident in his publication record wherein he has published more than 100 peer-reviewed and popular articles and attended numerous conferences and workshops (many times as an invited expert). However, it is his work on mustelids and otters more specifically that Dave is best known. Indeed, apart from publishing numerous papers on otters, he has also been a member of the IUCN/SSC Otter Specialist group since 1974 and acted as the coordinator for Africa between 1974 and 1996. Dave remains the "go to" individual for all things otter in Africa. Although retired (and at the age of 80!) he is still regularly contacted for his expert input and many of his early (and seminal) papers on otters continue to be widely cited. Another little-known fact about Dave is that he is also somewhat of a poet, having published a collection of 14 poems in a book entitled: "Green water, grey sand, and high places".

Dr Mike Mentis, a contemporary of Dave writes:

"*I have known Dave for more than 50 years as a colleague and a friend. I know no one who is more deserving of SAWMA's Wildlife Excellence Award. Possibly his humility and modesty mislead people. But for those who have worked with him, he is an astute observer of wildlife and people with has an admirable ability to read 'sign' and 'body language'. His work is always professional, perceptive and pragmatic. In his quiet way, Dave has been a foremost contributor, in substantive content and by example, to the science of South African wildlife management, and it has been an honour and privilege to travel the journey with him.*"

There is also an excellent video about Dave and his life available at:

https://sawma.co.za/award-winners-current-and-historical/