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

Robyn, F. WILSON,* And Nityasa NAMASKARI
School of Science, Monash University Malaysia,
Bandar Sunway, Selangor, Malaysia

*Corresponding author: robynwilsonpossum@gmail.com

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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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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).

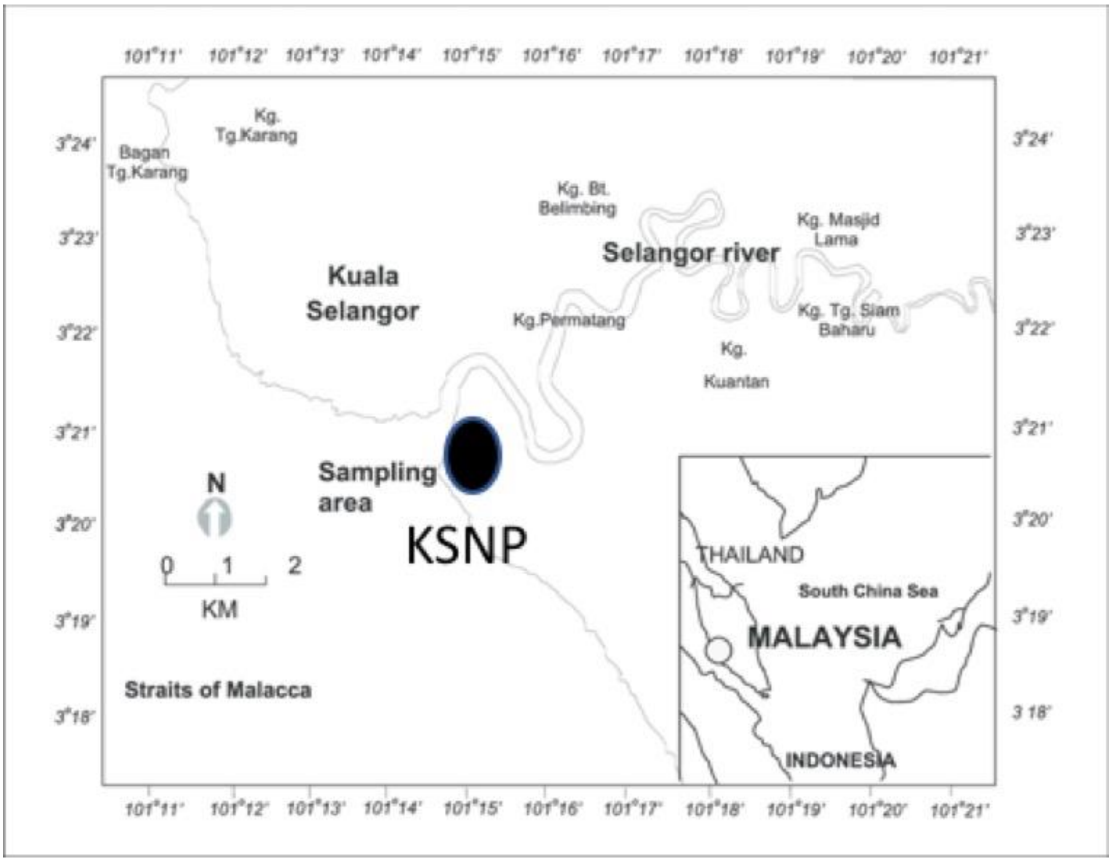

Figure 2. Sampling area (●) within Kuala Selangor Nature Park (KSNP) at the entrance to the Selangor River, Selangor, Malaysia

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 $\alpha=0.05$ 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 ($\chi^2_1=1.282$, $P=0.258$).

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

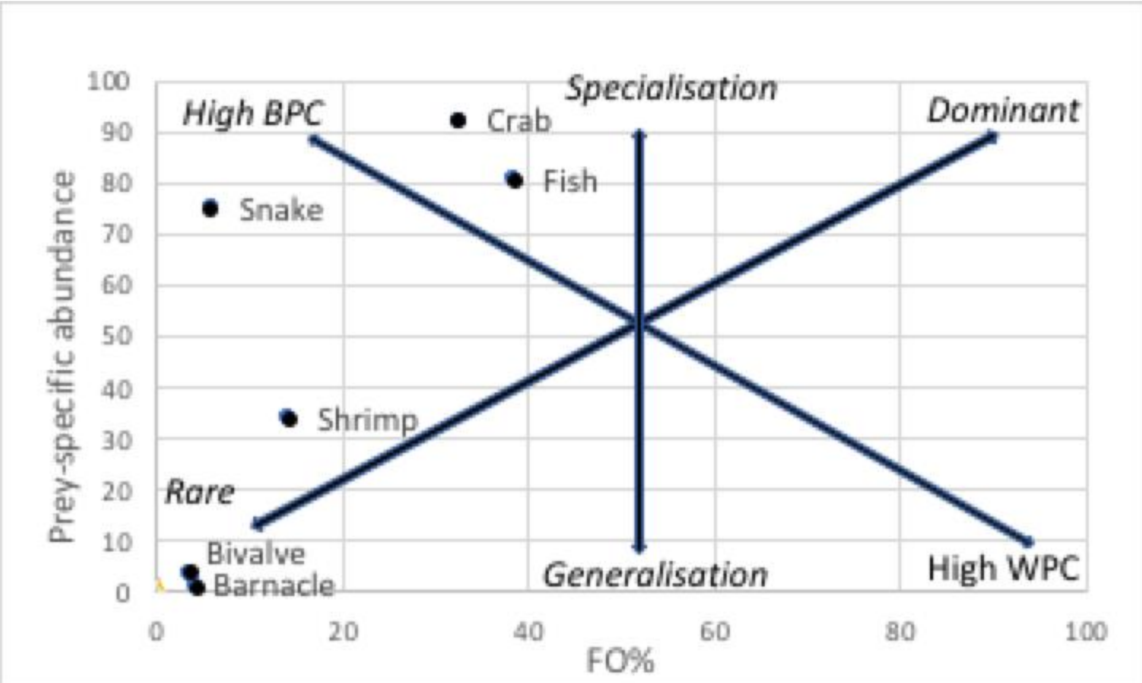

Figure 3. Relationship between Frequency of Occurrence (FO) and Prey-specific abundance indicating the feeding strategy, feeding importance and niche variation of the smooth-coated otter. Explanatory axes for foraging patterns follow Amundsen et al. (1996), modified from Costello (1990). The vertical 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).

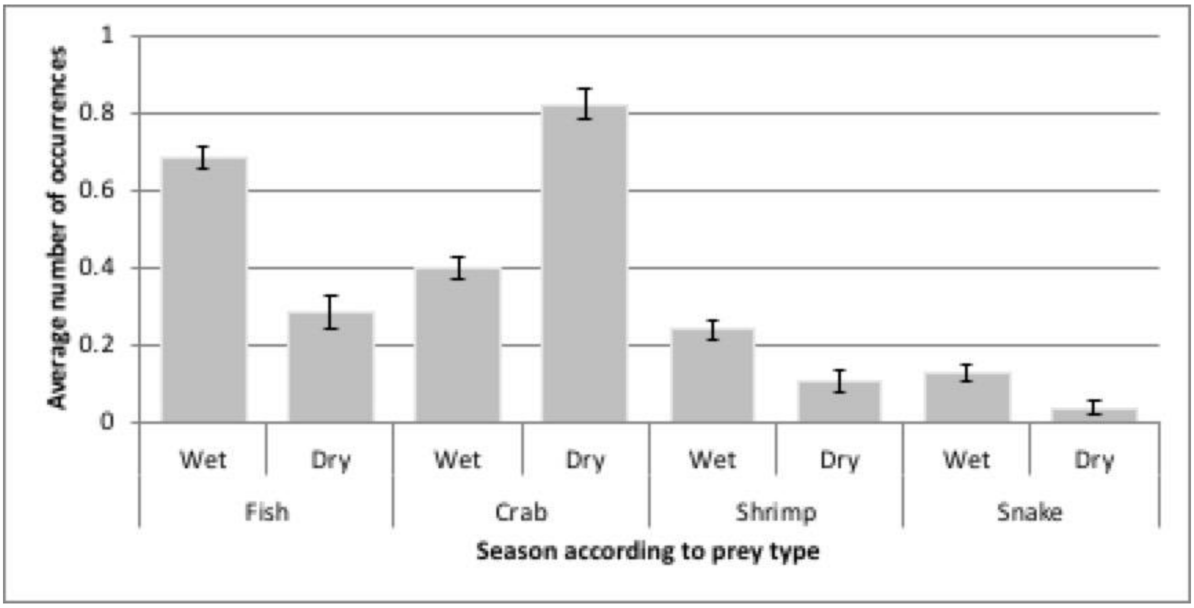

Figure 4. Average number of occurrences of each prey in spraint in each season (± 1 S.E.).

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.

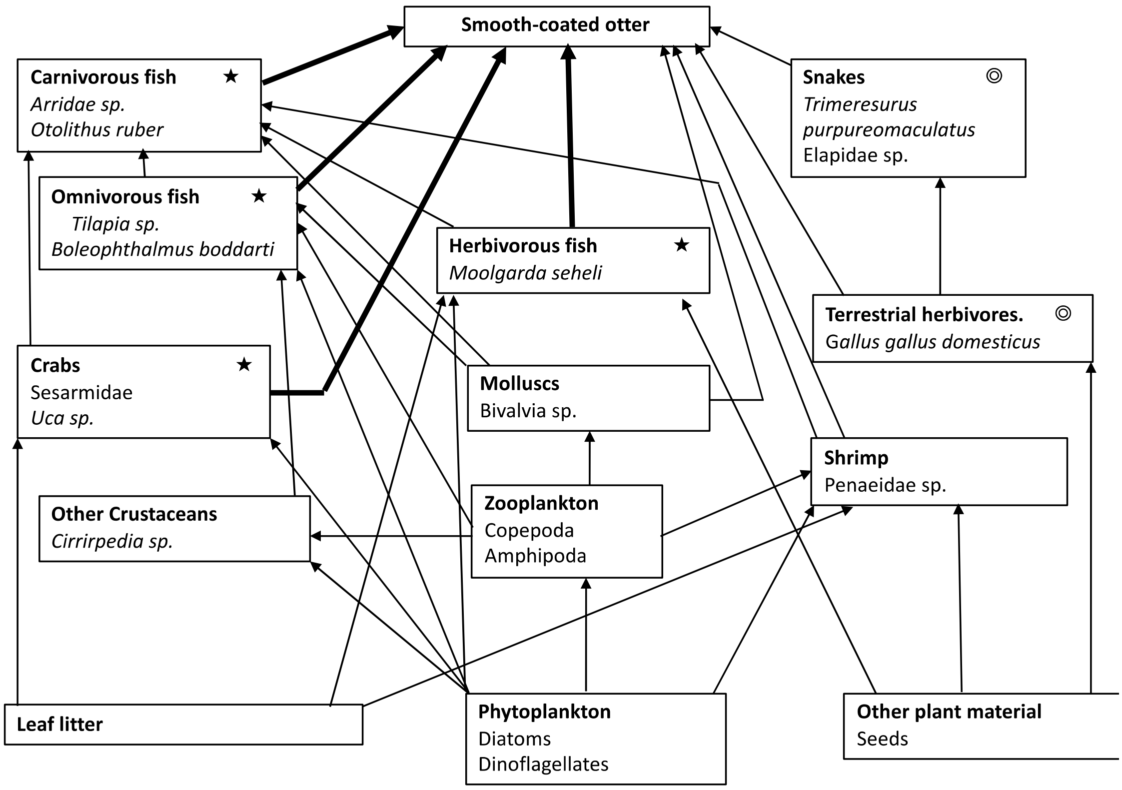

Figure 5. Food web created from the spraint of the smooth-coated otter, their prey in mangrove habitat, material in the gut of a fish reference collection and observations by interviewees. Prey marked by ★ and bold arrow were consumed in large numbers, and prey marked ◎ were observed being eatten by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

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

2. How often do you go fishing?
   ___days per week   ___hours per day

3. Where do you go fishing?
   ____

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

5. 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

6. Do you see otters eating the same things you are catching?
a. Yes b. No

If yes, what are they eating?

____

7. 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

____

8. 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

   ____