N O T E   F R O M   T H E   E D I T O R

NOTE FROM THE EDITOR

Dear Friends, Colleagues and Otter Enthusiasts!

I can only hope that you all are safe and healthy. I understood that some are already vaccinated. For the rest I hope we all manage to stay safe and healthy until it is our turn.

This year we are now much faster than in previous years to get manuscripts online. We are hard working with Lesley to remove all the backlog to the point when we will be able to upload each manuscript on the date the proofprint has been accepted by the authors.

You may be well aware that the IUCN OSG Bulletin, via me, became a member of the Committee on Publication Ethics (COPE) some years ago. As part of this, I sometimes use anti-plagiarism software to check manuscripts before sending them out for review. Another aspect is that authors submitting manuscripts should carefully consider the list of authors as there are strict rules on how to add an additional author after the original submission, which creates a lot of work for me and them.

I want to use the opportunity to ask all authors to carefully double check their reference, and the list of references. It is so much work for Lesley to sort this out and then, especially, find the missing references.

Many thanks to Lesley for all endless hours and hours spent not only for getting manuscripts online but also doing the extra work to double-check the manuscripts for typos and the one always missing reference.

R E P O R T

THE FIRST DOCUMENTED RECORD OF HAIRY–NOSED OTTER (*Lutra sumatrana*) IN THE LOWER KINABATANGAN WILDLIFE SANCTUARY, SABAH, MALAYSIA

Leona Wai[1,2], Richard Burger[1,2], and Benoit Goossens[1,2]

[1]Danau Girang Field Centre, c/o Sabah Wildlife Department, Wisma MUIS, Block B, 5th Floor, 88100 Kota Kinabalu, Sabah, Malaysia. E-mail: leonawai22@gmail.com
[2]Organisms and Environment Division, Cardiff School of Biosciences, Cardiff University, Sir Martin Evans Building, Museum Avenue, Cardiff CF10 3AX, UK.

(Received 20th May 2020, accepted 18th August 2020)

Abstract: On 7th March 2020, *L. sumatrana* was sighted and video recorded in an oil palm plantation within the Lower Kinabatangan Wildlife Sanctuary (LKWS). This was the first documented sighting of *L. sumatrana* within the LKWS, which suggests that this endangered otter species still persists within the degraded landscape. In addition, on the 8th September 2020, a roadkill of a hairy-nosed otter was found at a village about 30 km from the location of the first recorded sighting of hairy-nosed otter. Based on this finding, the LKWS acts as an essential wildlife corridor for endangered species such as *L. sumatrana*, which connects forest reserves such as Deramakot Forest Reserve and Tabin Wildlife Reserve. Very little is known about this rare species in Sabah due to a lack of scientific research. Therefore, targeted research on *L. sumatrana* is urgently needed to identify important otter habitat and establish a species management plan in Sabah.
Citation: Wai, L., Burger, R. and Goossens, B. (2021). The First Documented Record of Hairy–Nosed Otter (*Lutra sumatrana*) in the Lower Kinabatangan Wildlife Sanctuary, Sabah, Malaysia. *IUCN Otter Spec. Group Bull.* **38**(2): 62 -69
Keywords: *Lutra sumatrana*, degraded forest, Kinabatangan, Borneo

INTRODUCTION

One of the least known otter species, *Lutra sumatrana* is distributed across Southeast Asia; Thailand, Cambodia, Vietnam, Peninsular Malaysia, Borneo and Java (Kruuk, 2006; Payne and Francis, 2007; Phillips and Phillips, 2016). In the past, direct sightings of *L. sumatrana* were very rare and its occurrence was only determined by roadkill carcasses from Indonesia (Lubis, 2005) and Malaysia (Tan, 2015) and specimen records (Hiroshi et al., 2009). Recently, the species has been rediscovered via direct sightings and photographic evidence in many regions such as Cambodia in 1998 (Long, 2000), Sumatra in 2013 (Latifiana and Pickles, 2013) and Vietnam in 2000 (Dang et al., 2011). In Sabah, Malaysian Borneo, *L. sumatrana* was not seen for about 100 years and rediscovered in Deramakot Forest Reserve via a camera trap image (Wilting et al., 2010). Since then, there have been a few sightings around Sabah; Tabin Wildlife Reserve (Ishigami et al., 2017), Deramakot Forest Reserve (Guharajan pers comm., 2018; Gordon, pers comm., 2019) and Danum Valley Conservation Area (Pain pers comm., 2019).

Little is known about the habitat preferences of this very elusive otter species as it is very difficult to observe in the wild, thus only a few studies have been conducted on free-ranging *L. sumatrana*. This species is believed to occur in swamp forest, mangrove forest, lowland flooded forest, mountain streams and occasionally, oil palm plantation streams (Kruuk, 2006; Latifiana and Pickles, 2013; Payne and Francis, 2007; Phillips and Phillips, 2016; Sivasothi and Nor, 1994; Wright *et al.*, 2008). In the IUCN Red List, *L. sumatrana* is listed as Endangered, while in the Sabah Wildlife Conservation Enactment 1997, this species is listed in Schedule 2 (Protected Species). The knowledge on the population status of *L. sumatrana* in Sabah remains patchy due to lack of scientific surveys and research. Therefore, scientific research on this endangered species is urgently needed to better understand the ecology of the species for establishing conservation management planning.

SIGHTING DETAIL

Location (Map)

The sighting occurred along a man-made ridge at the boundary of an oil palm plantation in Lot 6 of the Lower Kinabatangan Wildlife Sanctuary (LKWS), located on the east coast of Sabah, Malaysia (Fig. 1). GPS coordinates of the sighting is N5.40505° E118.08327°. The oil palm plantation ridge is a raised area bordering the plantation, to prevent flooding from the Kinabatangan river, and planted with bamboo. The area is located adjacent to a swamp, a tributary, and the main river.

Since the 1950s, the LKWS has undergone drastic human changes in the form of logging and agriculture, predominantly being converted into monoculture landscapes of oil palm plantation (Ancrenaz et al., 2004). Abram et al. (2014) stated that 250,617 ha (48%) of Kinabatangan forest were converted into oil palm plantation. In 2002, the Sabah Wildlife Department gazetted a 27,000 ha area of the lower Kinabatangan floodplain as a Wildlife Sanctuary and divided it into 10 lots under provision of the Sabah Wildlife Conservation Enactment 1997. Despite the intense habitat fragmentation happening around the wildlife sanctuary, several Bornean species such as Bornean elephant (*Elephas maximus borneensis*), Sunda clouded leopard (*Neofelis diardi)*, Malayan sunbear (*Helarctos malayanus*) and binturong (*Arctictis binturong*) still persist in the floodplain (Abram et al., 2014; Ancrenaz et al., 2004; Evans et al., 2016). The LKWS provides an important forest corridor to connect forest reserves such as Deramakot Forest Reserve and Tabin Wildlife Reserve (Evans et al., 2016). The mean temperature of the area ranges from 21–34 °C (Ancrenaz et al., 2004) and average annual rainfall is 3,000 mm with occasional flooding and drought (Estes et al., 2012).

Time and Conditions

The sighting occurred along a man-made ridge at the border of a large oil palm plantation. The ridge is planted with bamboo, and also fenced with electrified wire, which is only turned on when Bornean elephants (*Elephas maximus borneensis*) are in the vicinity. It is bordered on the North by a riparian buffer zone of forest along the Kinabatangan river, with a minimum width of around 50m. On 7th March 2020, at 9.30 am, Richard Burger was walking with other researchers along the path along the top of the ridge, and observed a lone otter running towards them along the ridge path, heading East. The weather was clear and sunny. They remained motionless and quiet, while observing and filming the otter running towards them. Once the otter got to within ~15m, it slowed down and became more cautious, but still continued to move in their direction, appearing to be highly curious, until it was within 1 – 2m. It did not appear to be able to observe them clearly while they remained motionless, but it was frightened when Richard moved slightly due to filming the animal. It let out a brief snorting sound, and ran away off the ridge.

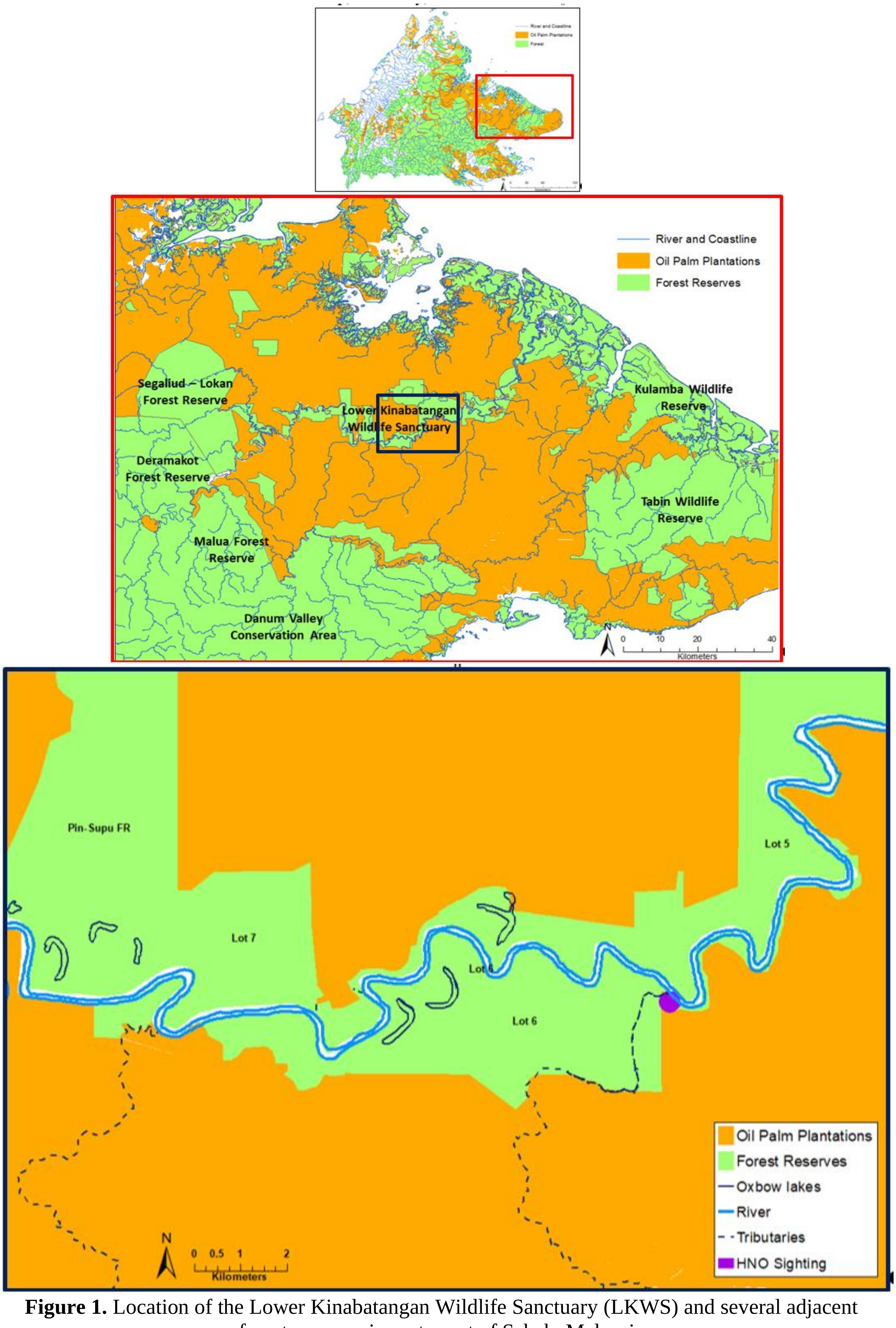


Figure 1. Location of the Lower Kinabatangan Wildlife Sanctuary (LKWS) and several adjacent forest reserves in east coast of Sabah, Malaysia

Compared to other otter species on Borneo, *L. sumatrana* (Fig. 2) has a few distinctive features such as its hairy rhinarium, white fur on the lips and upper throat and dark coat (Kruuk, 2006; Payne and Francis, 2007; Wright et al., 2008). This species weight ranges from 7 – 8 kg, while their head – body length ranges from 50 – 60 cm (Payne and Francis, 2007; Wright et al., 2008). This species is usually found solitary or in pairs, rarely in groups (Kruuk, 2006; Payne and Frances, 2007). The main diet of this species is fish, occasionally snakes, frogs, crabs, insects and small mammals (Kanchanasaka, 2001; Kruuk, 2006).

Figure 2, Still image of *L. sumatrana* from the video captured in Lot 6 of the Lower Kinabatangan Wildlife Sanctuary (LKWS). Distinctive white fur on the lips and upper throat were visible.

DISCUSSION

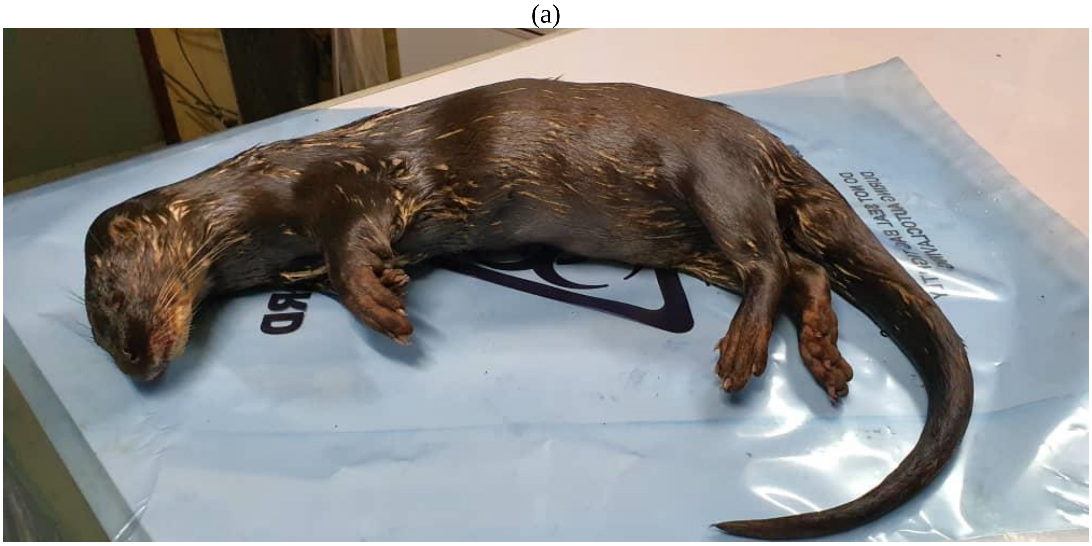
The occurrence of this rare otter species in degraded habitat could suggest that it may have higher tolerance towards human disturbance and may exist in broader range of habitats than originally presumed. This otter might have been sighted previously by the locals; however, they are generally unable to differentiate the four Bornean otter species (Wai, unpublished data). Therefore, education awareness on otters is needed to educate the local community in Sabah about the ecology and importance of otters. Moreover, this finding suggests that citizen science is urgently needed to gather local information on this endangered otter species by interviewing the local residents especially within the riverine community.

This finding also highlights the importance of LKWS as a wildlife corridor as it connects central forests such as Deramakot Forest Reserve to mangrove forests in the east coast of Sabah such as Tabin Wildlife Reserve, where *L. sumatrana* was previously recorded. Even though this rare species was sighted in the oil palm plantation, it is unlikely that *L. sumatrana* favors oil palm habitat. The area of sighting was in close proximity to swampy areas and the main river; the otter may have come from the swamp area and used the oil palm plantation ridge as a passage to the main river. While there have been a few records of *L. sumatrana* in Sabah, this information is not sufficient to assess their population status in the state. Therefore, it is imperative to conduct statewide surveys in Sabah to determine the population status and distribution of *L. sumatrana* and use this information to develop a species management plan and identify critical habitat for this endangered species.

ADDITIONAL INFORMATION

On the 8th September 2020, during the reviewing process of this paper, a roadkill of a hairy-nosed otter (Fig. 3) was found at Batu Puteh village, about 30 km from the location of the first recorded sighting of hairy-nosed otter in LKWS in 7th March 2020. The GPS location of the carcass was N5.408049° E117.948428°. According to the witness, Norsalleh Taing, there were 4 individuals crossing the road, and then a lorry hit one of the hairy-nosed otters. He then hurried to rescue the otter but the injuries were too critical and the otter died shortly thereafter. The carcass was brought to a veterinary clinic for post-mortem and measurements (Fig. 3 and Table 1) and the post-mortem was performed by Danau Girang Field Centre's veterinary, Dr. Macarena Gonzalez and Dr. Sergio Guerrero-Sanchez. Blood, serum, muscle, tissue and hair samples as well as important organs such as heart, lung, liver, stomach, intestines and kidney were extracted for forensic, genetic, diet and toxicology purposes. Samples were stored in a freezer (-80 °C) in Wildlife Health, Genetic and Forensic Laboratory, Potuki prior to analysis. The skull and skin samples were extracted at Museum Sabah, to be kept as a museum specimen collection. This roadkill is a very important finding in otter conservation in Sabah as we now have a confirmed DNA sample of a local hairy-nosed otter.

(a)



(b)

Figure 3. Pictures of the hairy-nosed otter carcass at the (a) accident scene and (b) cleaned and ready for post-mortem.

Table 1. Measurements of body parts of the hairy-nosed otter carcass

Body parts	Measurement
Age/ Sex	Sub-adult male
Weight	3.15 kg
Head to tail length	97 cm
Head to body length	60 cm
Tail length	37 cm
Body diameter	34.5 cm
Head length	12.7 cm
Head diameter	22.9 cm
Fore foot (Figure 4)	6.7 cm (length), 5.3 cm (width)
Hind foot (Figure 4)	7.3 cm (length), 4.6 cm (width)

(a) (b)

Figure 4: Scanned version of inked hairy-nosed otter's (a) fore foot and (b) hind foot

Acknowledgements - Sincere thanks to the IUCN Otter Specialist Group members for helping in the identification of the otter species. Deepest thanks to Nazrul bin Moh Natsyir, Nurul Aizatul, Nur Syafawati and Valerie Poinson for spotting this rare otter species as well as to Samsir, Elisa, Maz, Amanda, Ray, Ashraft, Dr. Liesbeth, Nurhartini and Alwanie for assisting in the post-mortem process. Special thanks to the Museum Sabah for extracting and storing the skull and skin sample. Many thanks are extended to the Sabah Wildlife Department for supporting our work in the LKWS.

REFERENCES

Abram, N. K., Xofis, P., Tzanopoulos, J., Macmillan, D. C., Ancrenaz, M., Chung, R., Peter, L., Ong, R., Lackman, I., Goossens, B., Ambu, L., Knight A. T. (2014). Synergies for improving oil palm production and forest conservation in floodplain landscapes. *PLoS ONE* **9**(6): 1-12.

Ancrenaz, M., Goossens, B., Gimenez, O., Sawang, A., Lackman-Ancrenaz, I. (2004). Determination of ape distribution and population size using ground and aerial surveys: a case study with orang-utans in lower Kinabatangan, Sabah, Malaysia. *Animal Conservation* **7**: 375-385.

Dang, N. X., Anh, P. T., Tuyen, L. H. (2001). New information about the hairy-nosed otter (*Lutra sumatrana*) in Vietnam. *IUCN Otter Specialist Group Bulletin* **18**(2): 1–8.

Estes, J. G., Othman N., Ismail S., Ancrenaz M., Goossens B., Ambu L. N., Estes A. B., Palmiotto P. A. (2012). Quantity and configuration of available elephant habitat and related conservation concerns in the Lower Kinabatangan Floodplain of Sabah, Malaysia. *PLoS ONE* **7**: e44601.

Evans, M. N., Vickers, S. H., Abu-Bakar, M. S., Goossens, B. (2016). Small carnivores of the Lower Kinabatangan Wildlife Sanctuary, Sabah, Borneo, including a new locality for the otter civet *Cynogale bennetti*. *Small Carnivore Conservation* **54**: 26-38.

Hiroshi, S., Burhanuddin, M.N., Budsabong, K. (2009). Past and present distribution of the Hairy-nosed Otter *Lutra sumatrana* Gray 1865. *Mammal Study* **34**: 223-229.

Ishigami, J., Ambu, L. N., Tuuga, A., Tsubouchi, T. (2017). The second recent record of hairy-nosed otter (*Lutra sumatrana*) in Sabah, Malaysia. *IUCN Otter Specialist Group Bulletin* **34** (1): 67 – 72

Kanchanasaka, B. (2001). Tracks and other signs of the hairy-nosed otter (*Lutra sumatrana*). *IUCN Otter Specialist Group Bulletin* **18**(2), 2–7.

Kruuk, H. (2006). Otters: ecology, behaviour and conservation. Oxford: Oxford University Press.

Latifiana, K., Pickles, R. (2013). New observation of the hairy-nosed otter (*Lutra sumatrana*) in Sumatra. *IUCN Otter Specialist Group Bulletin* **30**(2). 119-123.

Long, B. (2000). The hairy-nosed otter (*Lutra sumatrana*) in Cambodia. *IUCN Otter Specialist Group Bulletin* **17**(2): 91.

Lubis, R. (2005). First recent record of hairy-nosed otter in Sumatra, Indonesia. *IUCN Otter Specialist Group Bulletin*. **22**(1): 14-20.

Payne, J., Francis, C. M. (2007). A Field Guide to the Mammals of Borneo. Kota Kinabalu: The Sabah Society.

Phillips, Q., Phillips, K. (2016). Mammals of Borneo and Their Ecology: Sabah, Sarawak, Brunei and Kalimantan. Kota Kinabalu: Natural History Publications (Borneo).

Sabah Wildlife Department. (1997). Sabah Wildlife Conservation Enactment 1997.

Sivasothi, N., Nor, B. H. M. (1994). A review of otters (Carnivora: Mustelidae: Lutrinae) in Malaysia and Singapore. *Ecology and Conservation of Southeast Asian Marine and Freshwater Environments including Wetlands* **285**: 151-170.

Tan, H. H. (2015). A roadkill record of a hairy-nosed otter (*Lutra sumatrana*) from Selangor, Peninsular Malaysia. *IUCN Otter Specialist Group Bulletin* **32**(1): 8–11.

Wilting, A., Samejima, H., Mohamed, A. (2010). Diversity of Bornean viverrids and other small carnivores in Deramakot Forest Reserve, Sabah, Malaysia. *Small Carnivore Conservation* **42**: 10-13.

Wright, L., Olsson, A., Kanchanasaka, B. (2008). A working review of the hairy-nosed otter (*Lutra sumatrana*). *IUCN Otter Specialist Group Bulletin* **25**(1): 38–59.

RÉSUMÉ

PREMIERE OBSERVATION DE LA LOUTRE DE SUMATRA (*Lutra sumatrana*) DANS LA RÉSERVE FAUNISTIQUE DU BAS KINABATANGAN, AU SABAH, EN MALAYSIE

Le 7 mars 2020, L. *sumatrana* a été aperçue et une vidéo a été enregistrée dans une plantation de palmiers à huile de la Réserve Faunistique du Bas Kinabatangan (RFBK). Il s'agissait de la première observation documentée de L. *sumatrana* dans la RFBK, ce qui suggère que cette espèce de loutre en voie de disparition est toujours présente dans ce paysage dégradé. De plus, le 8 septembre 2020, une loutre de Sumatra, tuée suite à un accident de la route, a été trouvée dans un village à environ 30 km du lieu de la première observation enregistrée. Sur base de cette découverte, le LKWS se comporte comme un corridor faunistique essentiel pour les espèces menacées telles que L. *sumatrana*, et qui relie les réserves forestières telles que celle de Deramakot et la réserve faunistique de Tabin. On en sait très peu sur cette espèce rare au Sabah en raison d'un manque de recherche scientifique. Par conséquent, une recherche ciblée sur L. *sumatrana* est nécessaire de toute urgence pour identifier un habitat à loutre important et établir un plan de gestion de l'espèce au Sabah.

RESUMEN

PRIMER REGISTRO DOCUMENTADO DE NUTRIA SUMATRANA (*Lutra sumatrana*) EN EL SANTUARIO DE VIDA SILVESTRE DEL KINABATANGAN INFERIOR, SABAH, MALASIA

El 7 de Marzo de 2020, fue avistada y registrada en video una *L. sumatrana*, en una plantación de palmera aceitera del Santuario de Vida Silvestre del Kinabatangan Inferior (LKWS). Este fue el primer avistamiento documentado de *L. sumatrana* dentro del LKWS, lo que sugiere que esta especie amenazada de nutria aún persiste en el paisaje degradado. Adicionalmente, el 8 de Septiembre de 2020 se encontró un ejemplar de nutria de Sumatra atropellado, en un poblado a unos 30 km del sitio del primer avistamiento registrado de esta especie. Basados en éste hallazgo, el LKWS actúa como un corredor de fauna esencial para especies amenazadas como *L. sumatrana*, que conecta reservas forestales como la Reserva Forestal Deramakot y la Reserva de Vida Silvestre Tabin. Se sabe muy poco acerca de esta especie rara en Sabah, debido a la falta de investigación científica. Por lo tanto, se necesita urgentemente investigación focalizada en *L. sumatrana*, para identificar hábitat importante para las nutrias y establecer un plan de manejo de la especie en Sabah.

R E P O R T

THE SOCIAL AND ENVIRONMENTAL HISTORY OF THE RIVER WYE, WALES, AS VIEWED THROUGH THE CHANGING STATUS OF ITS EURASIAN OTTER (*Lutra lutra*) POPULATION

Fred M. SLATER

Honorary Senior Research Fellow, Cardiff University, Bridgehill, Newbridge-on-Wye, Llandrindod Wells, LD1 6LY, UK. e*-mail: slaterfm@cf.ac.uk*

(Received 23rd June 2020, accepted 28th August 2020)

Abstract: The River Wye has long had a social meaning to the people of Wales and further afield beginning with the search for the "picturesque" in the late eighteenth and early nineteenth centuries, through to the recognition of its environmental value with its designation as a Special Area of Conservation (SAC). The Eurasian otter (*Lutra lutra*), a key element in that designation of the Wye and at five other such sites in Wales, is the top predator on the river and as such reflects the cumulative changes over time within the riverine food chain and environment. Historically it lived in a river of such salmonid abundance that many poor families relied on salmon as their main protein resource with plenty left for a thriving otter population. Land use change leading to siltation of spawning grounds and agrochemical effects on otter reproduction resulted on the Wye, as elsewhere, in the species decline. Measures to stimulate recovery of the otter population have been well documented including regular surveys complemented by post-mortem analyses. The recovery has been accompanied by a greater awareness of the wider needs of the species as reflected in the provision of artificial holts and in underpasses etc. in new road developments. However, the positive elements of its changing status are not universally welcomed.

Citation: Slater, F.M. (2021). The Social and Environmental History of the River Wye, Wales, as viewed through the changing Status of its Eurasian Otter (*Lutra lutra*) Population. *IUCN Otter Spec. Group Bull.* **38** (2): 70 - 78

Key words: Otters, salmonids, eels, agrochemical pollution, social history, research.

INTRODUCTION

The River Wye in Wales, the UK's fifth longest river, has long been famed for being an early subject of the picturesque landscape movement (Gilpin, 1782; Price, 1796; Turner, 1826) which changed eighteenth and nineteenth century perceptions of landscape, and, with pastoral poet William Wordsworth's famous description of the "sylvan Wye" in a poem of 1798, effectively stimulated a tourist industry in the Wye Valley, a lucrative business which continues to the present day. The river initially received a Site of Special Scientific Interest (SSSI) designation from about 1972 eventually extending along its whole length, between Hereford and Chepstow it was declared an Area of Outstanding Natural Beauty (AONB) in 1971 and now has the highest European conservation designation (SAC). In 1854, George Borrow, author of *Wild Wales*, standing on Plynlimon (Pumlumon Fawr) mountain at the source of the River Wye thought it "*the most lovely river, probably, which the world can boast of*". All these personalities and events have embedded the river deeply in the social fabric of Wales.

Temporal changes in social and environmental history will inevitably be reflected, not only in the lives of the people at that time, but in the creatures affected by such changes, particularly if they are at the top of their food chain such as *Lutra lutra*, the Eurasian otter, and in the environments in which they live. The River Wye is, at 250 km (Natural Resources Wales data), the longest river in Wales, with a rural catchment of some 4136 km^2, one of the least polluted in England and Wales from non-agricultural sources, and is designated as a Special Area of Conservation (SAC) a designation in which the Eurasian otter (from here on referred to as "the otter") is a major factor. An important player in the social and environmental history of the otter is the Atlantic salmon (*Salmo salar*), which has always, when available, made up an important part of otter diet, and also been abundant as a food source for humans living near the Wye throughout written history. One of the earliest references to Wye salmon was by Gerald of Wales who, in 1191, noted that the Wye "*abounded with salmon, most numerously in winter*" (Thorpe, 1978) and some two centuries later they made up a significant part of the 3000 dried salmon Edward II in 1308 requisitioned from Wales for his Scottish campaign (Slater, 1988). Legislation protecting salmon fisheries, some dating back almost 800 years, had proved ineffective and even the Salmon Fisheries Act of 1861, which aimed to curb such practices as taking finger-sized parr as samlets, poisoning, spearing and gaffing of adults, did little reduce freshwater netting which was increasing in intensity and dramatically reducing salmon stocks. For example, the Miller Bros. who netted the river Wye upstream to Symond's Yat, in 1890 they caught 40,642 kg of salmon and by 1892 caught 61,843 kg. By 1900 the catch had fallen to 11,340 kg. In addition, salmon were heavily netted in other parts of the river, in the Severn Estuary and Bristol Channel. Control to save the salmon population required an almost complete ban on netting between 1901 and 1904 (Hutton, 1949).

Until well in to the nineteenth century, if a poor peasant in Wales could build a house overnight on common land, they could claim ownership of that piece of land. Often, such "night houses" (Tŷ Unnos) were on common land near rivers, to give the occupants free access to catch salmon to smoke and use as staple winter food – without which many of these people would starve. The Salmon Fisheries Act of 1861, and subsequent amendments, were passed to control exploitation of salmon stocks, but, because of the value of this resource to the poor, it ultimately lead to an orgy of poaching in protest at these controls, known on the upper Wye as the Second Rebecca Riots (the First were in the 1840s against road tolls) when, in one night at Rhayader in 1904, over 200 adult salmon were taken (Slater, 1988).

As, if not more, important than salmon as otter food, was the European eel (*Anguilla anguilla*). Eels were, for centuries, always the cheapest of fish and utilized by the entire spectrum of society. At the time of the Doomsday Book in 1086 hundreds of water mills in England and Wales paid their rent in eels. They were so common that they were used as a form of currency to pay tithes and rent, often counted in batches or "sticks" of 25 (Cain, 2018). A map of 1584 of Llangorse Lake, known as an important fishery at this time, shows an eel trap on its outflow to the River Llynfi, a tributary of the mid-Wye (Cain, 2018). An eel trap on the Lake still remains but is not operative as eel in the Wye have all but gone in the last three decades, but the village of Llyswen on the mid-Wye still bears a name possibly derived from the Welsh for eels, Llysywen. On the nearby River Severn, its source, like the Wye, is also on Plynlimon, it was said that the river was so stocked with eels, an important food of both otters and people, that over 1,000 kg were caught in one night in about 1900 at Melverley weir (Waters, 1949). But this time of plenty was about to change.

SOCIAL CHANGE AND ENVIRONMENTAL DECLINE

The presence of otters in Britain has been recorded in the archaeological record from Neolithic and Roman sites (Harris and Yalden, 2008) but not until the twelfth century from written hunting records (Cummins, 1988). It is recorded that otter skins were still were still articles of commerce at Builth Wells, on the middle reaches of the Wye, until the end of the seventeenth century where they were hunted for fur, sport and as "vermin" (Slater, 1988).

Enclosure Acts of 1700s and 1800s and Salmon Fisheries Acts often effectively gave ownership of commons and rivers to wealthy landowners leading to considerable social change and political unrest including the end of the Tŷ unnos concept (Slater, 1988). Although otter hunting dates to at least the early medieval period, otter hunting for sport peaked in late 1800s and early 1900s when UK hunts annually killed thousands of otters as "vermin" in the UK. Over 1200 were killed in England and Wales in the period 1950-55 and the eleven hunts in England and Wales from 1958-1963 killed 1065 otters (Jefferies, 1989). Stevens (1957) reported that otter numbers improved after the First World War and by 1939 were "comparatively common". Numbers dropped during the Second World War but increased in the post-war period with the Wye River Board reporting "there are plenty of otters on the rivers. They are said to be numerous on the Lugg" (a Wye tributary.) "Plenty" and "numerous" were not terms Walker (1970) would have used when, between 1955 and 1970, he estimated a drop of 75% in the otter population on the River Wye. He noted a marked decline following the severe winter of 1962-63 when the Wye tributaries were frozen and snowed over, and slow deep waters on the main river were icebound. Consequently, he suggests, otters could normally turn to alternative prey such as rabbits, but in 1963 myxomatosis made rabbits very scarce and many otters probably died of starvation – but no recovery followed. Full time otter hunts before this decline would regularly kill three to six otters a day on the Wye tributaries which fell to virtually nil on many days post-decline. Walker's observations on the causes of the decline need to be supplemented by the effects of dieldrin, an organochlorine sheep dip and cereal dressing introduced in 1955-56 and banned in 1966.

The local Otter Hunt (Hawkstone) had found mean weights of male otters had decreased significantly from 11.75 kg 1926-36 to 10.23 kg 1936-46 to 9.90 kg 1946-56 as hunting pressure prevented them reaching maturity (Jefferies, 1997). Concurrently, the average weight of rod caught Wye salmon fell from 7.08 kg in 1906-1910 to 5.22 kg 1979-1983 (Strachan, 2015). The mean the weight of roadkill otters has also declined over time, probably because of increasing numbers of younger animals in the recovering population (Chadwick, 2007).

After over hunting, over fishing and organochlorine sheep-dips had taken their toll, otters, at the top of the riverine food chain, began to be affected by other environmental factors such as, acidification due to air pollution, exacerbated by coniferisation of the uplands; siltation of spawning grounds, again due to drainage for forestry and agricultural land improvement. Another important otter food resource in the Wye, the native crayfish *Austropotamobius pallipes* was itself reduced to near extinction by the 1980s due to crayfish plague, sheep dip and siltation. On the mid-Wye crayfish constituted much of otter diet before the crustacean's decline (although there is evidence that this "native" species was introduced!) (Slater, 1988).

Since the 1980s, Henderson et al. (2012), report an average 15% per year decline in yellow eels in Bridgewater Bay, Somerset, with abundance in 2009 being only 1% of that in 1980. About a century earlier, in 1904, Sir Herbert Maxwell wrote in his book *British Freshwater Fishes* "*the resources of our waters in the matter of eels is well-nigh inexhaustible*". How things have changed! This rapid decline in eels as a food resource has had undoubted consequences for otters (Strachan et al., 2006).

RECOVERY AND RESEARCH

The Eurasian otter and its habitat have full legal protection as a European Protected Species (EPS), and it is also protected under sections 9 and 11 of the UK Wildlife and Countryside Act 1981. Salmon, an important otter food item, has protection under the Salmon & Freshwater Fisheries Act, 1975 and because of its decline in recent decades, the exploitation of eels is controlled under the Eels (England and Wales) Regulations, 2009.

A better understanding of the needs of the animal on the Wye, and more generally, has been achieved through the Cardiff University Otter Project which began in 1992 from Cardiff University's Field Centre at Newbridge-on-Wye in mid-Wales, an interest which emerged from a number of early studies of the species and peripheral involvement in the Otter Surveys of Wales from the 1970s. In the early 2000s, with the closure of the Field Centre, the Project moved its base to the School of Biosciences at Cardiff University and has continued to received otter carcasses for post-mortem and subsequent studies, of which only example publications are given here:

- genetics (Hobbs et al., 2006; Stanton et al., 2009; O'Neill et al., 2013; Thomas et al., 2019; Mead et al., 2020)
- chemical communication (Bradshaw et al, 2001; Kean et al., 2015, 2017)
- toxicology (Chadwick et al., 2011; Walker et al., 2011; Kean et al, 2013; Pountney et al., 2015)
- diet (Slater and Rayner, 1993; Slater, 2002; Williams Schwartz et al., 2018; Drake et al., 2019; Moorhouse- Gann et al., 2020)
- parasitology (Sherrard-Smith et al., 2009, 2012, 2015)
- population structure (Smallbone et al., 2017)
- dispersal (Stanton et al., 2014; Thomas et al., 2019)
- age (Chadwick and Sherrard-Smith, 2010)
- reproductive status (Sherrard-Smith and Chadwick, 2010)
- morphometrics (Sherrard-Smith and Chadwick, 2010)
- behaviour (Cowell et al., 2001)

A TIME TO BE HAPPY (ALMOST)

Fortunately, since the population lows of three decades ago, the otter population of the United Kingdom continues to recover and can be illustrated in Wales by the percentage of sites occupied on Welsh rivers recorded in repeated surveys in 1977-78 (Crawford et al., 1979), 1984-85 (Andrews and Crawford, 1986), 1991(Andrews et al., 1993), 2002 (Jones and Jones, 2004), 2009-10 (Strachan, 2015) where, on the River Wye, the overall positive sites increased from 24% in 1977 to 97% in 2010 which Strachan (2015) believed was approaching carrying capacity although they measured otter presence not actual population size (Strachan and Jefferies, 1996). However, food resources do not seem as yet to be limiting, as introduced species of crayfish replace natives, still water fisheries and garden ponds increasingly attract otter attention, more coastal/estuarine records are made and from the author's own observations on the mid-Wye, amphibians dominate diet in spring.

Although better sewage treatment; controls on sheep dip disposal; treatment of mine waste waters; removal of barriers to fish movement such as impassable weirs; and reduced acidification all potentially aid the recovery of some salmon populations (Wye Usk Foundation), environmental problems still remain. The effects of climate change on the population viability of mainly migratory fish is unclear. Road death numbers in otters continue to rise but only, it seems, roughly in proportion to their increasing numbers(Strachan, 2015); many pollutants recorded from otters at post-mortem exceed risk levels quoted for other species (Kean and Chadwick, 2012); sedimentation from intensified agricultural and forestry activities cause problems for otter prey species due to a build-up of sediment-adsorbed heavy metals; loss of interstitial space within gravels for fish eggs and invertebrate habitat including for crayfish; eutrophication from phosphates and nitrates and increased BOD. To counteract part of this problem Nitrate Vulnerable Zones have been declared in many parts of the country including parts of the Wye (Strachan, 2015). In the uplands, although acid pulses from peatland, drained mainly for forestry, and particulate flushing from conifer foliage, have reduced due to the introduction of siltation traps and modified drainage patterns and improving air quality it is of concern that levels of sulphur and nitrogen in precipitation remain relatively high (15-25 kg S/ha/yr and 20-25 kg N/ha/yr , Strachan, 2015). Acidity below pH 5.5 excludes bullhead (*Cottus gobio*) and kills salmon alevins which reduces fish stocks and, in turn, potentially the carrying capacity of otters (Strachan, 2015).

The near complete loss of the native, White-clawed Crayfish (*Austropotamobius pallipes*) from the mid-Wye catchment, due largely to crayfish plague, sheep dip pollution and siltation, has deprived the otter in this region of a former principal food resource. However, the American Signal Crayfish (*Pacifastacus* leniusculus), carrier of the plague which has largely destroyed *A. pallipes*, was introduced in the 1970s to fish farms in the Wye and adjacent catchments, and has now escaped these farms and spread to dominate the invertebrate biomass of several former *A. pallipes* strongholds. It these situations, *P. leniusculus* has seemingly replaced the *A. pallipes* element in otter diet but not without creating further environmental change due to its more aggressive feeding habits (Slater, 1988). To aid its control, it is now illegal to trap or catch *P. leniusculus* without a licence and no commercial exploitation of crayfish is allowed in designated controlled (no-go) areas. *P. leniusculus* is currently one of about eight alien crayfish species present in the British Isles so problems associated with the species may only be indicative of potential future problems.

Although the number of otters killed on Welsh and English roads continues to increase, it is probably a proportional harvest of an increasing population (Strachan, 2015). In Wales, the Welsh Government leads a partnership of organisations interested in the implementation of mitigation measures to reduce otter deaths called the Roads and Otters Steering Group. Otter mortality black spots are identified, and remedial actions suggested, in line with Grogan et al (2001) and incorporated in the technical advice given in the Standards for Highways Design Manual for Roads and Bridges (15 volumes 2020). Mitigation measures in various otter scenarios include, artificial holts, underpasses, ledges, the need for otter guards on legally used fyke nets and otter proof fencing. Since the 1970s artificial otter holts (National Rivers Authority, 1993) and bankside fencing have been constructed on many water courses in Wales, including the Wye, for the benefit of these animals, although the general need for artificial holts has declined as the population of otters expands and there seem to be sufficient natural holts (Grogan, 2001).

Otters have become increasingly popular in the eyes of the public. In 2020 it was voted Scotland's favourite native species and Britain's favourite mammal in 2008. Organisations such as the Wye/Usk Foundation in Wales have spent years improving the riverine habitat to the benefit of otters, following on from practical work on otter conservation and distribution by the Vincent Wildlife Trust beginning in the 1970s. Public participation through local recording of otter signs has been encouraged by, for example, the South Wales Otter Trust. In literature the otter has been depicted in a favourable light in books as diverse as *Wind in the Willows* by Kenneth Grahame and Henry Williamson's *Tarka the Otter*, the latter coming second in 2019 in a poll of Britain's Favourite Piece of Nature Writing. The otter has appeared in J.K. Rowling's Harry Potter series and gained popularity in the book and film of Ring of Bright Water by Gavin Maxwell. All in all, a positive social perception of the otter has continued to increase as its population has recovered. As Pete Cooper (2016) put it:

"The otter transcends the world we know and the one we don't, and therein lies our deep fascination. A top predator of our rivers and wetlands, mysterious yet familiar and a true comeback-kid that shows that through working together, we can make a difference to the fortunes of the natural world; the otter is a great candidate to champion UK mammals"

Sadly, the rapid recovery of otter populations has created genuine problems, especially for still water fisheries both in Britain and Europe (Kranz, 2000; Spur et al., 2018) and to a lesser extent the owners of ornamental fishponds (Green, 1998). On a commercial level this problem is recognized by the appropriate authorities and the only real answer seems to be otter proof fencing, meaning, that the wheel of social history has come full circle and in certain situations there are calls once again to control otters as "vermin".

REFERENCES

Andrews, E., Crawford, A.K. (1986). Otter Survey of Wales 1984-85. Vincent Wildlife Trust, London.

Andrews, E., Howell, P., Johnson, K. (1993). Otter Survey of Wales 1991. Vincent Wildlife Trust, London.

Bradshaw, A, Beckmann, M, Stevens, R., Slater, F.M. (2001). Anal scent gland secretion of the European otter (*Lutra lutra*). *Ninth International Symposium on Chemical Signals in Vertebrates,* Krakow, Poland, 25-29 July 2000. Published in: **Marchlewska-Koj, A., Lepri, J., Muller-Schwarze, D.** (Eds.) Chemical Signals in Vertebrates, vol. 9. New York, NY: Kluwer, pp. 313-319.

Cain, G. (2018). Exploring the Kingdom of Brycheiniog: An Integrated Archaeological Approach in an Early Medieval Landscape. MSc thesis, Kellogg College, University of Oxford.

Chadwick, E.A. (2007). Post-mortem study of otters (*Lutra lutra*) in England and Wales. Science Report SC 010065/SR.2007, 1-129. Environment Agency. Bristol.

Chadwick, E.A., Sherrard-Smith, E., (2010). Pregnancy among otters (*Lutra lutra*) found dead in England and Wales: foetal development and lack of seasonality. *IUCN Otter Specialist Bulletin*, **27**: 33-41.

Chadwick, E.A., Simpson, V.R., Nicholls, A.E.L., Slater, F.M. (2011). Lead levels in Eurasian otters decline with time and reveal interactions between sources, prevailing weather, and stream chemistry. *Environmental Science and Technology* **45**: 1911-1916.

Chadwick, E.A., Cable, J., Chinchen, A., Francis, J., Guy, E., Kean, E.F., Paul, S.C., Perkins, S.E., Sherrard-Smith, E., Wilkinson, C., Forman, D.W. (2013). Seroprevalence of *Toxoplasma gondii* in the Eurasian otter (*Lutra lutra*) in England and Wales. *Parasites & Vectors*, **6**(1): 75.

Cooper, P. (2016). *Otter Magic*. Royal Society of Biology Blog 26/10/2016.

Cowell, D., Thomas, G., Liles, G., Bradshaw, A., Midgley, L., Slater, F. (2001). Monitoring the use of artificial log pile otter holts using hair analysis from bedding. *IUCN Otter Specialist Group Bulletin*, **18**: 6-10.

Crawford, A., Evans, D., Jones, A., McNulty, J. (1979). *Otter Survey of Wales 1977-78.* Society for the Promotion of Nature Conservation, Lincoln.

Cummins, J. (1988). The hound and the hawk: the art of medieval hunting. Weidenfeld & Nicolson, London.

Drake, L., Symondson, W.O.C., McDonald, R.A., Chadwick E.A. (2019). Otterly delicious: investigating the diet of the Eurasian otter (*Lutra lutra*) using high throughput sequencing and stable isotope analysis. p30, Book of Abstracts. *33rd European Mustelid Colloquium* October 2019, Lisbon.

Edgington, S. B. (1981). Vermin in Buckden 1627-1774. *Huntingdonshire Fauna and Flora Society Annual Report*, **B33**: 31-37.

Gilpin, W. (1782). Observations on the River Wye and Several Parts of South Wales Relative Chiefly to Picturesque Beauty Made in the Summer of the Year 1770. London.

Green, R. (1998). Otters as predators in ornamental ponds. *BOKU-Res Wildlife Resources & Game Management,* **14**: 20-22.

Grogan, A., Philcox, C., Macdonald, D.W. (2001). Nature Conservation and Roads: Advice in relation to otters. WildCRU/Highways Agency, London.

Harris, S. & Yalden, D.W. (eds.) (2008). Mammals of the British Isles: Handbook 4th Edition. The Mammal Society, Southampton.

Henderson, P.A., Plenty, S.J., Newton, L.C., Bird, D.J. (2012). Evidence for a population collapse of European eel (*Anguilla anguilla*) in the Bristol Channel. *Journal of the Marine Biological Association of the United Kingdom,* **92**: 843-851.

Hobbs, G., Chadwick, E., Slater, F., Bruford, M. (2006). Landscape genetics applied to a recovering otter (*Lutra lutra*) population in the UK: preliminary results and potential methodologies. *Hystrix, the Italian Journal of Mammalogy*, ***17***: 47-63.

Hutton, J.A. (1949). Wye Salmon and Other Fish. Altrincham: John Sherratt and Son

Jefferies, D.J. (1997). Decline and recovery of the otter – a personal account. *British Wildlife*. **7**: 353-364.

Jones, T., Jones, D. (2004). Otter Survey of Wales 2002. Environment Agency Wales, Cardiff.

Kean, E.F., Müller, C.T., Chadwick, E.A. (2011). Otter scent signals age, sex, and reproductive status. *Chemical Senses*, ***36***: 555-564.

Kean, E.F., Chadwick, E.A. (2012). Mammal records verification rule sets for NBN Record Cleaner and recommendations on species whose records should be treated as sensitive. *Mammal Society and NBN Report*. Available at: http://www.nbn.org.uk/nbn_wide/media/Documents/Def

Kean, E.F., Gwynne, L., Chadwick, E.A. (2013). Persistent organic pollutants and indicators of otter health. [Project Report]. *CHEMTrust*. Available at: https://chemtrust.org/wp-content/uploads/Otter-Health-Pollutants-V8-DesignedV4-FINAL.pdf

Kean, E.F., Chadwick, E.A., Muller, C.T. (2015). Scent signals individual identity and country of origin in otters. *Mammalian Biology* **80**: 99-105.

Kean, E.F., Bruford, M.W., Russo, I. M., Muller, C.T., Chadwick, E.A. (2017). Odour dialects among wild mammals. Scientific Reports **7**: 13593. 10.1038/s41598-017-12706-8

Kranz, A. (2000). Otter (*Lutra lutra*) increase in Central Europe: from threat of extinction to locally perceived overpopulation? *Mammalia* **64**: 357-368.

Maxwell, H. (1904). *British Freshwater Fishes.* Hutchinson & Co. London.

Mead, D., Hailer, F., Chadwick, E.A., Portela M., R., Smith, M., Corton, C., Oliver, K., Skelton, J., Betteridge, E., Doulcan, J., Dudchenko, O., Omer, A., Weisz, D., Lieberman A., McCarthy, S., Howe, K., Sims, Y., Torrance, J., Tracey, A., Challis, R., Durbin, R., Blaxter, M. (2020). The genome sequence of the Eurasian river otter, *Lutra lutra* Linnaeus 1758. *Wellcome Open Research* **5**: 33.

Moorhouse-Gann, R.J., Kean, E.F., Parry, G., Valladares, S., Chadwick, E.A. (2020). Dietary complexity and hidden costs of prey switching in a generalist top predator. *Ecology and Evolution*; **10**: 6395-6408.

National Rivers Authority. (1993). Otters and River Habitat Management. Conservation Technical Handbook No 3. National Rivers Authority, Bristol

O'Neill, D., Turner, P.D., O'Meara, D.B., Chadwick, E.A., Coffey, L., O'Reilly, C. (2013). Development of novel real-time TaqMan®PCR assays for the species and sex identification of otter (*Lutra lutra*) and their application to non-invasive genetic monitoring. *Molecular Ecology Resources* **13** (5): 877-883.

Pountney, A., Filby, A.L., Thomas, G.O., Simpson, V.R., Chadwick, E.A., Stevens, J.R., Tyler, C.R. (2015). High liver content of polybrominated diphenyl ether (PBDE) in otters *(Lutra lutra*) from England and Wales. *Chemosphere*, **118:** 81-86.

Price, Sir Uvedale, (1796). An essay on the Picturesque. Hereford, London.

Sherrard-Smith, E., Cable, J., Chadwick, E.A. (2009). Distribution of Eurasian otter biliary parasites, *Pseudamphistomum truncatum* and *Metorchis albidus* (Family Opisthorchiidae), in England and Wales. *Parasitology*, **136**(9): 1015-1022.

Sherrard-Smith, E., Chadwick, E.A. (2010). Age structure of the otter *(Lutra lutra*) population in England and Wales, and problems with cementum ageing. *IUCN Otter Specialist Group Bulletin*, **27**(1): 42-49.

Sherrard-Smith, E., Chadwick, E., Cable, J. (2012). Abiotic and biotic factors associated with tick population dynamics on a mammalian host: *Ixodes hexagonus* infesting otters, *Lutra lutra*. *PLOS One*, **7(**10): .e47131.

Sherrard-Smith, E., Perkins, S.E., Chadwick, E.A., Cable, J., (2015). Spatial and seasonal factors are key determinants in the aggregation of helminths in their definitive hosts: *Pseudamphistomum truncatum* in otters (*Lutra lutra*). *International Journal for Parasitology*, **45**(1): 75-83.

Slater, F.M. (1988). *The Nature of Central Wales*. Barracuda Books, Buckingham.

Slater, F. M., Rayner, G. (1993). *Austropotamobius pallipes* in otter diet in the mid-Wye catchment of central Wales. *Freshwater Crayfish* **9**: 365-367.

Slater, F.M. (2002). Progressive skinning of toads (*Bufo bufo*) by the Eurasian otter (*Lutra lutra*). *IUCN Otter Specialist Group Bulletin* **19** (1): 25-29.

Smallbone, W.A., Chadwick, E.A., Francis, J., Guy E., Perkins, S.E., Sherrard-Smith, E. and Cable J. (2017) East-West Divide: temperature and land cover drive spatial variation of Toxoplasma gondii infection in Eurasian otters (*Lutra lutra*) from England and Wales. *Parasitology*.**144**(11): 1433-1440. doi: 10.1017/S0031182017000865.

Spur, N., Gomboc, K.Z., Sorgo, A. (2018). Public acceptability of measures to prevent from predation on commercial fish by endangered Eurasian otter (*Lutra lutra*). *Journal for Nature Conservation, **44***: 21-32.

Stanton, D.W.G., Hobbs, G.I., Chadwick, E.A., Slater, F.M., Bruford, M.W. (2009). Mitochondrial genetic diversity and structure of the European otter (*Lutra lutra*) in Britain. *Conservation Genetics,* **10**(3): 733-737.

Stanton, D.W.G., Hobbs, G.I., McCafferty, D.J., Chadwick, E.A., Philbey, A.W., Saccheri, I.J., Slater, F.M. and Bruford, M.W. (2014). Contrasting genetic structure of the Eurasian otter (*Lutra lutra*) across a latitudinal divide. *Journal of Mammalogy* **95** (4): 814-823. (DOI: 10.1644/13-MAMM-A-201)

Stevens, M.N. (1957). The Otter Report. UFAW London.

Strachan, R. (2015). Otter Survey of Wales 2009-10. Natural Resources Wales, Cardiff.

Strachan, R., Jefferies, D.J. (**1996).** Otter Survey of England 1991-94. Vincent Wildlife Trust, London.

Strachan, R., Williamson, K., Hall, C., Baylis, J. (2006). Dietary Study of Otters using the Coast of North West Wales. Species Challenge Report to Countryside Council for Wales, Bangor.

Thomas, N.E., Hailer, F., MacDonald R.A., Bruford, M.W., Chadwick, E.A. (2019). Population genetic changes during recolonization of the UK by the Eurasian otter (*Lutra lutra*). p40, Book of Abstracts. *33rd European Mustelid Colloquium* October 2019, Lisbon.

Thorpe, L. (1978) (Translator). Gerald of Wales. The Journey through Wales and Description of Wales. Penguin, Harmondsworth.

Turner, J.M.W. (1826). Picturesque Views in England & Wales. From Drawings Principally Made by J.M.W. Turner. London.

Walker, C.W. (1970). The Otter in Radnorshire. Chapter XV in Welsh Wildlife in Trust. In: **Lacey W.S.** (ed). North Wales Naturalists' Trust, Bangor.

Walker, L.A., Lawlor, A.J., Chadwick, E.A., Potter, E., Pereira, M.G., Shore, R.F., (2011). Inorganic elements in the livers of Eurasian otters, *Lutra lutra*, from England and Wales in 2007 and 2008: *Predatory Bird Monitoring Scheme (PBMS) report. Centre for Ecology & Hydrology, Lancaster, UK*, pp.1-13.

Waters, B. (1949). *Severn Stream*. Dent, London.

Williams Schwartz, A., Williams, H.F., Chadwick, E.A., Thomas, R.J., Perkins, S.E. (2018). Roadkill scavenging behaviour in an urban environment. *Journal of Urban Ecology* **4** (1): juy006.

RÉSUMÉ: L'HISTOIRE SOCIALE ET ENVIRONNEMENTALE DE LA RIVIÈRE WYE, AU PAYS DE GALLES, VUE À TRAVERS LE CHANGEMENT DU STATUT DE SA POPULATION DE LOUTRE EURASIENNE (*Lutra lutra*)

La rivière Wye a longtemps eu une signification sociale pour les habitants du Pays de Galles et bien au-delà, à commencer par la recherche du «picturesque» à la fin du XVIIIe et au début du XIXe siècle, jusqu'à la reconnaissance de sa valeur environnementale avec sa désignation comme Zone Spéciale de Conservation (ZSC). La loutre eurasienne *(Lutra lutra*), un élément clé dans cette désignation de la rivière Wye et dans cinq autres sites de ce type au Pays de Galles, est le principal prédateur de la rivière et en tant que telle reflète les changements cumulatifs au fil du temps au sein de la chaîne trophique fluviale et de l'environnement. Historiquement, elle vivait dans une rivière d'une telle abondance de salmonidés que de nombreuses familles pauvres dépendaient du saumon comme principale source de protéines, avec des réserves pléthoriques pour une population de loutres florissante. Le changement d'affectation des sols a eu pour conséquence l'envasement des frayères et des effets agrochimiques sur la reproduction de la loutre, ce qui a entraîné sur la rivière Wye, comme ailleurs, le déclin de l'espèce. Les mesures visant à stimuler le rétablissement de la population de loutres ont été bien documentées, notamment par des suivis réguliers complétés par des analyses post-mortem. Le rétablissement s'est accompagné d'une plus grande prise de conscience des besoins plus larges de l'espèce, comme en témoigne l'installation de catiches artificielles et de passages souterrains etc. dans le cadre des nouveaux projets routiers. Cependant, les éléments positifs de son changement de statut ne sont pas universellement bien accueillis.

RESUMEN: HISTORIA SOCIAL Y AMBIENTAL DEL RÍO WYE, GALES, VISTA A TRAVÉS DEL ESTATUS CAMBIANTE DE SU POBLACIÓN DE NUTRIA EURASIÁTICA (*Lutra Lutra*)

El río Wye ha tenido desde hace mucho tiempo un significado social para la gente de Gales (y no sólo de Gales), empezando por la búsqueda de lo "pintoresco" a fines del siglo 18 y comienzos del 19, hasta el reconocimiento de su valor ambiental con su designación como Area Especial de Conservación (SAC). La nutria eurasiática (*Lutra lutra*), un elemento clave en la designación del Wye y de otros cinco tales áreas en Gales, es el predador tope en el río, y como tal refleja los cambios en la cadena alimentaria y el ambiente riparios, acumulativos a lo largo del tiempo. Históricamente, vivió en un río con tal abundancia de salmónidos que muchas familias pobres obtenían su principal fuente de proteína del salmón, quedando aún así muchos para una próspera población de nutrias. El cambio del uso de la tierra conducente a sedimentación en los ambientes de desove y a efectos de agroquímicos en la reproducción de nutrias, resultó en que en el Wye, como en tantos otros lugares, la especie declinara. Las medidas para estimular la recuperación de la población de nutrias han sido bien documentadas, incluyendo prospecciones regulares complementadas por análisis post-mortem. La recuperación ha sido acompañada por una mayor conciencia acerca de las necesidades integrales de la especie, lo que se reflejó en la provisión de refugios artificiales, y pasos de fauna, etc en los nuevos desarrollos viales. Sin embargo, los elementos positivos de su estatus cambiante no son universalmente bienvenidos.

S H O R T   N O T E

FIRST RECORD OF AN ELUSIVE PREDATOR: THE SMOOTH-COATED OTTER (*Lutrogale perspicillata*) FROM VADUVOOR BIRD SANCTUARY, THIRUVARUR DISTRICT, TAMIL NADU, SOUTHERN INDIA

Kanagasabai ARIVOLI[1], **Kannadasan NARASIMMARAJAN**[2*]

[1]District Forest Officer, Tamil Nadu Forest Department, Thiruvarur District, Pin- 610 004 Tamil Nadu, India.
[2]Department of Zoology, Madras Christian College, East Tambaram, Chennai, Pin- 600 059 Tamil Nadu, India. e-mail: wildlife9protect@gmail.com*

(Received 7th August2020, accepted 30thAugust 2020)

Abstract: Vaduvoor Bird Sanctuary is one of the oldest bird sanctuaries in the state of Tamil Nadu, spanning over the area of about 128.10 ha. During March and June 2020 camera trap survey was carried-out in the sanctuary to examine the nocturnal animals and their movements. We deployed eight trap cameras randomly within the bird sanctuary. On 14th and 15th March 2020 about 1.30 AM a family of Smooth-coated otter was captured comprising of six adult individuals and no cubs were seen. Till date no otter has been reported from the Vaduvoor Bird Sanctuary. This report presents the first ever information on the new distribution range of the Smooth-coated otters from this region, but extensive surveys are necessary to generate reliable abundance estimates and distribution patterns for otters in this region and neighboring water bodies.

Keywords: Smooth-coated otter; Vaduvoor Bird Sanctuary; Camera trap; Conservation

INTRODUCTION

Three species of otters are found in India, namely the *Lutrogale perspicillata* (Smooth-coated otter), *Lutra lutra* (Eurasian otter) and *Aonyx cinerea* (Oriental small-clawed otter) (Foster-Turley and Santiapillai, 1990; Hussain, 2008). Throughout India the existing populations of the three species of otters and their habitat have not been surveyed systematically and hence not much information is available on their status (Hussain, 2008). All three species of otters have been reported from the Southern Indian part of the Western Ghats (Shenoy, 2003) but no records exist from the coastal districts of Tamil Nadu.

The Smooth-coated otter (*Lutrogale perspicillata*) is listed as ‘Vulnerable’ under IUCN Redlist (IUCN 2019). The animal lives in water bodies such as streams, rivers, lakes and dams (Kruuk, 1987), and are most vulnerable to local extinctions, since the most important threat to the survival of otter populations are the degradation of clean aquatic ecosystems (Foster-Turley, 1992). Smooth-coated otters are thought to be extinct in countries like Laos and India has a steadily declining population according to IUCN status reports (Shenoy, 2003). Other major threats to otters in India include illegal trade (Meena, 2002), reduced prey-availability persecution by fishermen and water pollution (Mason and MacDonald, 1986). At high trophic, levels otters are victim to the accumulation of contaminants in the food chains (Foster-Turley, 1992). Hence this species requires immediate conservation attention. No previous studies were conducted on otter conservation in Vaduvoor Bird Sanctuary and this is the first ever otter report from this region.

STUDY AREA

Vaduvoor Bird Sanctuary (10°42'9.39"N latitude and 79°19'4.94"E longitude) is located in Vaduvoor Agraharam Panchayat of Mannargudi Taluk of Tiruvarur district, Tamil Nadu (Fig. 1). The sanctuary is basically an irrigation tank that receives water from Cauvery basin and North East monsoon from August to December and it remains dry from April to June (Subramanya 2005). The tank is also called as Sri Kodandaramaswami Eri. The Sanctuary bounded by Kondaiyur village in North, Vaduvoor thenpathi village in South, Vaduvoor agraharam village in East and Neivasal village in West. The Kannanar and Vaduvoor canals are the main source of water to the wetland in addition to northeast monsoon. The area receives more than 384 mm rainfall annually and climate varies from 24 °C to 38 °C (Wetland Management Report, 2013).

The sanctuary covers an area of 128.10 ha and was created in 1999. The sanctuary attracts more than 80 species of wetland birds like Oriental white ibis (*Thresiornis melanocephalus*), Painted stork (*Mycteria leucocephala*), Spot-billed pelican (*Pelecanus philiensis*), Northenpintail (*Anas acuta*), cormorants, teals andherons among others (Subramanya 2005). The sanctuary has been identified as one of the Important Bird Areas (IBA) of India by Indian Bird Conservation Network. The sanctuary is rich in aquatic flora, with submerged, floating and emergent vegetation such as Pink morning glory (*Ipomia carnea*) and common water hyacinth (*Pontederia crassipes*). The vegetation of the sanctuary is mainly composed of *Prosopis juliflora, Azadirachta indica, Tamarindus indica,* including planted *Acacia nilotica* by the forest department under the Sanctuary Management Programme (Subramanya 2005). The area surrounding the Vaduvoor Bird Sanctuary is densely populated with the human population density being 437.4 person/km^2. A large population depends on the sanctuary for their livelihood thus making biodiversity conservation a highly difficult task.

METHODS

We surveyed the lake part of the sanctuary randomly using automatically triggered trap cameras (Cuddeback20MP X-Change Color Day and Night Model 1279 Game Hunting Camera). We deployed 8 trap cameras in random locations within the bird sanctuary during March and June 2020. The survey mainly focuses to study the nocturnal animal movements.

RESULTS

On 14th and 15th March 2020 an otter family was captured during the camera trap survey between 1.17 AM and 1.30 AM and the family consisted of six individuals (Figure 1, 2 and 3). This report presents the first ever otter information on the distribution range in the region. Further survey is ongoing to enumerate the movement pattern and resource use pattern of otters. Otters could possibly come from the Kannanar River. This river has many check dams which hold the water during the summer season. Two third of the tank has water up to the depth of 6 feet to 15 feet remaining area of North and Western parts has densely vegetated by *Acacia nilotica and Ipomia carnea*. Apparently, nearby fish farms are the vital source of food for them during the dry seasons but, no conflict has been recorded between the otters and the farm owners. Further studies will help the concern department and other stakeholders to protect the vulnerable otters in this region.

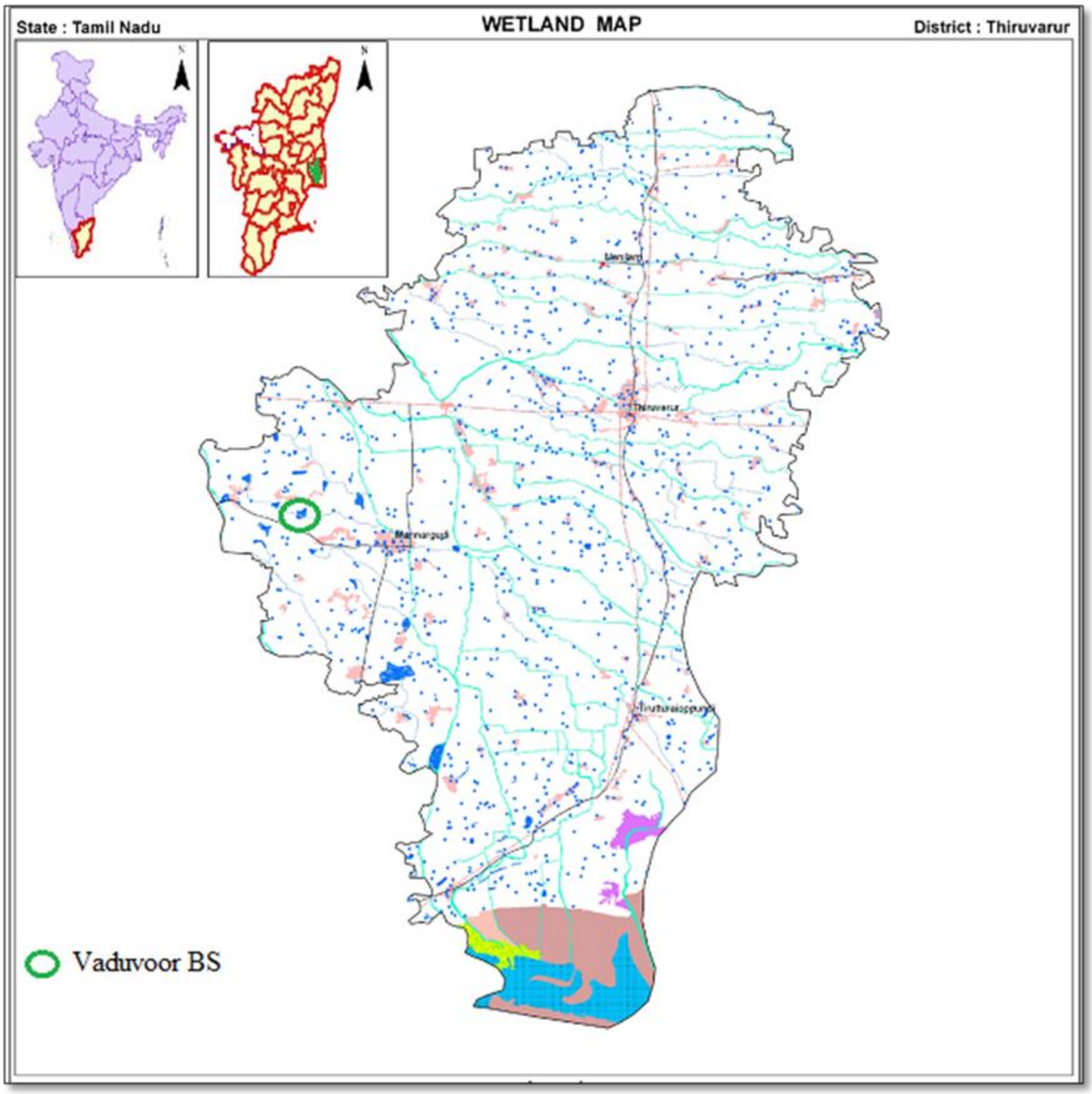


Figure 1. Vaduvoor Bird Sanctuary as seen in February 2020; Thiruvarur District, Tamil Nadu, Southern India.

DISCUSSION

Historically Tamil Nadu is water dearth state in India. So, safeguarding existing wetland ecosystems are fundamental for species and people. Wetlands are open ecosystems vulnerable to degradation from terrestrial land uses. The potential of a wetland top predator such as the Smooth-coated otter (*Lutrogale perspicillata*) as a 'proxy' for conservation of wetland habitats has been least studied in India. Being aquatic carnivore, the intactness of land water continuum is critical for survival of otters. Increasing trends of global warming and developmental activities are impacting the wetland habitat thereby losing their associated species in many parts of the country. So, preserving the wetland ecosystems using otters as flagship species is advisable vendetta.


3/15/2020 1:17 AM
Cuddeback
Digital


3/15/2020 1:19 AM
Cuddeback
Digital

Figure 1-3. Camera trap pictures of Smooth-coated otters captured from Vaduvoor Bird Sanctuary, Tamil Nadu on 14th and 15th March 2020.

ACKNOWLEDGEMENTS -We would like to thank the Tamil Nadu Forests Department for their immense encouragements. We would like to thank Mr. Suresh, Forest Guard for his constant help during the field work and two anonymous referees and their constructive comments to improve the quality of the manuscript.

REFERENCES

Foster-Turley, P., Santiapillai, C. (1990). Action plan for Asian otters., pp. 52-63. In: **Foster-Turley, P., Macdonald S.M., Mason C.F.**(Eds.).: Otters: An Action Plan for their Conservation. IUCN/SSC Otter Specialist Group.

Foster-Turley, P., (1992). Conservation ecology of sympatric Asian otters *Aonyx cinerea* and *Lutra perspicillata*. Ph. D. Thesis. University of Florida. 172pp.

Hussain, S.A. (2008). Otter conservation in India. *Envis Bulletin - Wildlife and Protected Areas.* **2**: 92-97.

Kruuk, H., Conroy, J.W.H. (1987). Surveying otters *Lutra lutra* populations: a discussion of problems with spraints. *BioI. Conserv*. 41: 179-183.

Mason, C.F., Macdonald, S.M. (1986). Otters - Ecology and Conservation. Cambridge University Press, Cambridge, London. 236 pp.

Meena, V. (2002). Otter poaching in Palani Hills. *Zoos Print Journal*. 17(2): 696-698.

Subramanya, S. (2005). Heronries of Tamil Nadu. *Indian Birds*, Vol (6): 126-140

Shenoy, K. (2003). 'Against the current': Otters in the River Cauvery, Karnatka, Wildlife Trust of India, New Delhi. 31pp.

Wetland Action Plan (2013). Tamil Nadu Forest Department drafting report. pp. 1-98.

RÉSUMÉ

PREMIER ENREGISTREMENT D'UN PRÉDATEUR DISCRET, LA LOUTRE À PELAGE LISSE (*Lutrogale perspicillata*) DANS LA RÉSERVE NATURELLE ORNITHOLOGIQUE DE VADUVOOR, DISTRICT DE TIHRUVARUR, TAMIL NADU, AU SUD DE L'INDE

La réserve naturelle ornithologique de Vaduvoor est l'une des plus anciennes réserves ornithologiques de l'État du Tamil Nadu, s'étendant sur une superficie d'environ 128,10 ha. En mars et juin 2020, une enquête a été réalisée dans la réserve naturelle à l'aide de pièges photographiques pour examiner les animaux nocturnes et leurs mouvements. Nous y avons installé huit pièges photos de manière aléatoire. Les 14 et 15 mars 2020, vers 1h30 du matin, une famille de loutres à pelage lisse a été observée dont six individus adultes et aucun loutron. Jusqu'à ce jour, aucune loutre n'avait été signalée dans la réserve naturelle ornithologique de Vaduvoor. Ce rapport présente les toutes premières informations sur la nouvelle aire de répartition de la loutre à pelage lisse de cette région, mais des relevés approfondis sont nécessaires afin d'avoir des estimations fiables de l'abondance et des modèles de distribution des loutres dans cette région et les plans d'eau voisins.

RESUMEN

PRIMER REGISTRO DE UN PREDADOR ELUSIVO: LA NUTRIA LISA (*Lutrogale perspicillata*) EN EL SANTUARIO DE AVES VADUVOOR, DISTRITO DE THIRUVARUR, TAMIL NADU, INDIA DEL SUR

El Santuario de Aves Vaduvoor es uno de los más antiguos del estado de Tamil Nadu, ocupando una superficie de 128.10 ha. Durante Marzo y Junio de 2020 llevamos a cabo un relevamiento con cámaras-trampa en el santuraio para examinar los animales nocturnos y sus movimientos. Desplegamos ocho cámaras-trampa al azar en el santuario. El 14 y 15 de Marzo de 2020, alrededor de la 1.30 AM, se capturó (fotográficamente) una familia de nutria lisa, compuesta de seis individuos adultos; no se vieron crías. Hasta la fecha, no se habían reportado nutrias lisas del Santuario de Aves Vaduvoor. Este informe presenta la primera información existente sobre la distribución de nutria lisa en esta región, pero se necesitan relevamientos extensivos para generar estimaciones de abundancia y patrones de distribución confiables, para las nutrias de esta región y cuerpos de agua vecinos.

R E P O R T

MONITORED RELEASE OF SMOOTH-COATED OTTERS (*Lutrogale perspicillata*) IN ANGKOR ARCHEOLOGICAL PARK, SIEM REAP, CAMBODIA

Nicole LEROUX[1*], Bunthoeun ROTH[1,2], Nick MARX[1]

[1]*Wildlife Rescue and Care Programs, Wildlife Alliance, N°86, Street 123, Toul Tompong I, Phnom Penh, Cambodia. Fax: +855-23-211-672.*
[2]*Institute of Forest and Wildlife Research, Forestry Administration, N°40, Preah Norodom Blvd (41), Phnom Penh, Cambodia.*
**Corresponding Author: leroux@wildlifealliance.org*

(Received 7th August 2020, accepted 30th August 2020)

Abstract: A family of smooth-coated otters (*Lutrogale perspicillata*) from Phnom Tamao Wildlife Rescue Center (PTWRC), Takeo, Cambodia, was reintroduced into the Angkor Archeological Park, Siem Reap, Cambodia, following IUCN Reintroduction Guidelines. Protocols included pre-release site surveys, candidate selection, health checks, rehabilitation and training, followed by acclimatization at the release site and post-release supplementary feeding and daily monitoring to ensure the continued survival and welfare of the released otters. The family, composing one male, one female and three offspring, was transported from PTWRC to a previously prepared release enclosure within the protected forest surrounding the Angkor Archeological Park for acclimatization. Following the death of two offspring due to eating poisonous toad eggs within the pre-release enclosure, the surviving three otters were released. The remaining juvenile disappeared approximately three weeks later, shortly after which the adult pair produced two pups. The family of four continues to survive, now six months after their release.

Citation:\Leroux, N., Roth, B. and Marx, N. (2021). Monitored Release of Smooth-Coated Otters (*Lutrogale perspicillata*) in Angkor Archeological Park, Siem Reap, Cambodia. *IUCN Otter Spec. Group Bull*. **38** (2): 85 - 93
Keywords: IUCN, post-release monitoring, Reintroduction Guidelines, rewilding, soft-release protocols.

INTRODUCTION

Reintroduction of rescued or captive-bred animals is an accepted conservation strategy to mitigate declining populations of species in the wild (Kleiman, 1989; Beck et al., 1994; Sjöåsen, 1996; Johnson and Berkley, 1999; Duplaix and Savage, 2018). Hard release - the reintroduction of animals without conducting any measures regarding monitoring or support – may be appropriate for certain species. Animals that have spent a prolonged time in captivity may have lost some of the abilities and behaviors necessary to survive in the wild and should be soft-released under IUCN Reintroduction Guidelines to increase the likelihood of survival and welfare (Beck et al., 1994). These include release site surveys, candidate selection, health checks, rehabilitation, acclimatization at the release site, post-release supplementary feeding and monitoring (IUCN/SCC, 2013).

Since 2001, Wildlife Alliance has been supporting the Cambodian Forestry Administration (FA) with its care for rescued wildlife at Phnom Tamao Wildlife

Rescue Center (PTWRC), Takeo, Cambodia. Set within regenerated forest, it is Cambodia's main government-run wildlife rehabilitation facility. Whenever possible, wildlife rehabilitated at PTWRC and suitable for reintroduction will be released into appropriate, protected habitat. For certain species, individuals unfit for release are put into captive-breeding programs and their offspring are returned to the wild at a later date if suitable. Wildlife Alliance implements strict reintroduction protocols when involved in the release of captive-born animals or those that have spent extended periods in captivity, from PTWRC.

Three otter species have been confirmed in Cambodia; Asian small-clawed (*Aonyx cinereus*), hairy-nosed (*Lutra sumatrana*) and smooth-coated otter (*Lutrogale perspicillata*) (Bennetto, 2009). Populations of all three species are decreasing due to land encroachment, habitat conversion, pollution, competition with humans for prey hunting and the pet trade (Aadrean et al., 2015; de Silva et al., 2015; Wright et al., 2015; Gomez and Shepherd, 2019). Of the three species, smooth-coated otters are more commonly encountered (Santiapillai, 2000; Bennetto, 2009). They also encompass the majority of otters rescued or donated to PTWRC.

Otters at PTWRC are often rescued from the pet trade. They will usually have been hand-raised by humans and habituated, which may make them unsuitable release candidates. Following a quarantine period, an appropriate male and female will be paired, as smooth-coated otters are monogamous with groups generally composed of a breeding pair and their multiple litters. A family of otters kept in an enclosure in a designated area of the center, which is off-access to the public, exhibited natural behavior, including a preference to avoid humans. This group was considered for potential release.

In 2019 the otters were taken to a pre-release enclosure within the protected forest surrounding the Angkor Archaeological Park, Siem Reap, Cambodia, as part of a larger rewilding initiative. The otters were kept in the on-site enclosure for five months and soft-released, following IUCN Reintroduction Guidelines (IUCN/SCC, 2013). Here we document the soft-release protocols employed, challenges faced and outcomes from the first recorded release of rehabilitated smooth-coated otters in Cambodia, as a resource for future practitioners looking to conduct similar reintroduction programs.

ANIMALS, MATERIALS AND METHODS

Site Selection

Suitable release sites in Cambodia for most species are limited by the presence of wild resident conspecifics or lack of adequate protection. In 2013, in partnership with FA and the authority managing Angkor, APSARA, Wildlife Alliance began a program to reintroduce a variety of species into the forest surrounding the Angkor Archaeological Park. Surveys of the area conducted in 2006, including line transects and interviews of villagers living nearby, found little wildlife remained in the area, and no presence of otters (Leroux et al., 2019). Wildlife populations have been reduced due to illegal hunting and logging in the '80s and '90s (Le Billon, 2000). APSARA and police within the Park are now effectively protecting the area and it is a designated UNESCO World Heritage site, safeguarding the Park from further human encroachment. We built the pre-release enclosure in a remote area of forest within the Angkor Thom complex, which holds several large bodies of water including lakes and moats and is not heavily visited by tourists.

Ethical Statement

All activities documented adhered to the legal requirements of Cambodia at all times with approval from the relevant government authorities. Transport and handling of animals was overseen by Wildlife Alliance lead veterinary and senior animal care staff.

Reintroduction Candidates, Health Checks and Pre-release training

The otters selected for reintroduction consisted of an adult male and female introduced into the enclosure in 2016, and their three captive-born dependent offspring. Offspring were from two different litters: one pup born in 2017, and two pups born in 2018. Otters were vaccinated for distemper annually. Health-checks were restricted by limited diagnostic facilities available for animals in Cambodia: blood chemistry testing to ensure normal levels for the species and examination of baseline physiological parameters. Rehabilitation conditions at PTWRC included a 50 m x 50 m enclosure, built around a section of the forest including different types of natural vegetation, logs, large rocks and roots, natural substrates which allowed digging, concrete dens for sleeping and an artificial concrete pond. The pool measured 5x4x1.5 m at the deepest point. The enclosure was located in an area of the center that is off-access to the public and isolated from other mustelid species to limit disease transmission. Following selection, the otters had minimum contact with animal care staff, limited to feeding and cleaning. We implemented behavioral enrichment feeds to encourage foraging and provided live fish in their pools so otters could acquire hunting skills. The otters were able to forage for enrichment feeds, such as snails and crabs, hunt for live fish, and catch frogs that wandered into the enclosure. They demonstrated other natural behavior such as swimming, scent-marking, digging and avoidance of humans.

Acclimatization

Animal care and veterinary staff captured the otters and transported them in two crates to the release site on July 3rd, 2019 (Fig. 1). The otters were acclimatized in the pre-release enclosure for five months. The enclosure is constructed around a section of forest and measures 60 m x 60 m with metal sheeting on the upper half to discourage the otters from climbing. It contains an artificial pool measuring 6 m x 4 m x 1.5 m at the deepest point, and two small sleeping dens made of concrete measuring 1.5 m x 1.5 m x 1 m (Fig. 2). The substrate is of soil, allowing otters to dig. We fed the otter family approximately 4 kg of live and dead fish per day in the afternoons (1 kg per adult otter, with a reduced amount for offspring). Fish species provided were dependent on availability in the market and predominantly included walking catfish (*Clarias* spp.) and Java barb (*Barbodes gonionotus*). Fish was supplemented by enrichment feeds of freshwater eels, crabs and snails provided at random times, every two or three days.

Post-release monitoring and supplementary feeding

Animal care staff installed a camera trap at the enclosure door to noninvasively monitor the otters' movements and conducted *ad hoc* visual observations throughout the day. As there are no wild conspecifics present in the area, the otters were easily identified. Supplementary feeding was provided in the same manner as we fed the otters during their acclimatization period in the enclosure, provided in and around the concrete pool. We initially fed a slightly reduced amount (just under 1 kg per adult otter), however increased the amount and split the feeds into morning and afternoon to encourage otters to remain close to the pre-release enclosure. Supplementary feeding is continued as a management tool for as long as we deem necessary and the otters return to feed.

Figure 1. Rehabilitated smooth-coated otters (*Lutrogale perspicillata)* introduced into the forested pre-release enclosure at the Angkor Archeological Park, Siem Reap, Cambodia.

Figure 2. Smooth-coated otters (*Lutrogale perspicillata)* using concrete den built within the pre-release enclosure, Angkor Archaeological Park, Siem Reap, Cambodia.

OBSERVATIONS

During their acclimatization period in the pre-release enclosure, the otters initially slept in the small dens we provided, later moving into holts they dug themselves in the ground. On November 3rd, two of the younger otters died after eating the poisonous toad eggs that were washed into the enclosure following heavy rains. In mid-November, the remaining otters escaped by digging under the enclosure fencing. We recaptured the family when they returned inside the enclosure to feed by blocking their exit. Shortly after this, we decided to release the group, removing the barrier under the fence and opening the main enclosure door.

In the first few weeks, the otters moved around during daylight, returning through the tunnel they created to sleep in the dens they had dug within the pre-release enclosure each day. They avoided people, running away if approached. Following the disappearance of the third young otter, last seen on December 6th, the adults became more secretive, preferring to venture out in the evenings and early mornings. However, they still returned in the afternoons for the supplementary feed. Animal care staff observed the otters daily, locating them as far as 3 km away from the release site. We split supplementary feeding to two times a day (morning and afternoon) and increased the quantity provided (just over 1 kg per adult otter per day) to ensure the otters did not venture into unsafe areas or those heavily visited by tourists. The extra feed reduced the distances the otters travelled as the extra nourishment removed the group's need to explore too far from the area for alternative food sources.

Towards the end of December 2019, the pair's behavior changed. They remained close to the pre-release enclosure, becoming more elusive and they dug a hole within the roots of a large tree, outside the pre-release enclosure, around 20 m away, in which they slept. On February 22nd 2020, animal care staff saw two pups for the first time accompanying the adult otters as they came to feed. Though small, the pups were well developed and we estimated them to be around six weeks old.

There have been only two encounters to cause concern following the otters' release so far. On May 14th, we found footage on YouTube of village dogs attacking the adult otters. The breeding pair charged the dogs in their defense. The footage, which continued for around 20 minutes, did not show the result. The following morning the otters were in the pre-release enclosure for supplementary feeding without any visible injuries, which suggests they defended themselves successfully. However, it is unclear when the footage was taken, as the pups were not present in the video and therefore it could have been recorded before their birth. The second incident occurred at the end of May when one of the wild-born pups was caught in an illegal fishing trap within the nearby lake. The fisherman fell over as he attempted to free the young otter and was attacked by the adults, subsequently requiring hospitalization for a brief period. When staff went to release the pup, they found it had already managed to make its way out of the trap and rejoined the family.

DISCUSSION

In the six months following their release, the adult otters and their wild-born offspring continue to survive. The rehabilitation and release of the adult pair can be considered a success thus far, as they have bred and continue to thrive with these offspring (Kleiman, 1989; Kleiman et al., 1991; Johnson and Berkley, 1999). However, it is not a complete success as two captive-born offspring died from consuming poisonous toad eggs in the pre-release enclosure during acclimatization and one disappeared within the first few weeks of their release.

The death of the offspring in our release initiative does not suggest captive-born smooth-coated otters should not be considered for reintroduction programs. Reintroduced captive-bred carnivores, including otters, have lower survival rates than their wild-caught counterparts as they are more likely to be habituated, resulting in human-caused mortality, or unable to forage and hunt for themselves once in the wild (Sjöåsen, 1996; Jule et al., 2008). The two captive-born offspring in our release died in the enclosure of causes unrelated to habituation or dependence on humans, and the third offspring's fate remains unknown. With proper rehabilitation and pre-release training specific to species biological and ecological needs, captive-bred or hand-reared animals that have spent prolonged periods in captivity can acquire skills necessary for survival in the wild (Beck et al., 1994; Somers and Markus, 2009; Reading et al., 2013; Dey et al., 2018). For the smooth-coated otters, rehabilitation following reintroduction protocols included limiting human contact, allowing pups to be raised by their parents, and providing enrichment and an environment to encourage natural behavior. As a result, the adults who spent an extended period in captivity, demonstrated appropriate behavior required for survival in the wild prior to and following release; foraging, hunting live fish, digging dens, avoiding humans and protecting their young.

The protocols and release site selection in our smooth-coated otter reintroduction differed from previous otter releases. Releases of a smooth-coated otter and giant otters (*Pteronura brasiliensis*) have been conducted using orphaned animals that have been hand-raised by practitioners (Gómez et al., 1999; Mcturk and Spelman, 2005; Dey et al., 2018). Our protocols limited human interaction with candidates, allowing offspring to be raised by their parents without intervention, as often animals raised by conspecifics are more easily and quickly able to develop appropriate natural behaviors needed for survival (Nicholson et al., 2007). Sites of previous otter releases have contained wild conspecifics (McTurk and Spelman, 2005; Dey et al., 2018). The release of a single hand-reared male smooth-coated otter selected a site with resident otters and was ultimately a success (Dey et al., 2018). Releases of hand-reared orphaned giant otters into habitat with wild groups had mixed results: the majority of individuals were adopted into or mixed with wild groups; however, about a sixth of released otters were killed by wild conspecifics (Gómez et al., 1999; Mcturk and Spelman, 2005). We chose an area with no resident smooth-coated otters present, as we were concerned they would outcompete the released individuals for resources, possibly driving them from protected and ideal habitat, and potentially could lead to intraspecies-caused conflict or mortality (Kleiman and Beck, 1994; Sjöåsen, 1997; IUCN/SCC, 1998; Mcturk and Spelman, 2005; Dey et al., 2018). Our selected release site influenced our candidate selection; we released an established family group similar to that found in the wild to increase likelihood of survival as they navigate their new environment, rather than releasing individuals (Kleiman and Beck, 1994; Batson et al., 2015).

Post-release monitoring gives us knowledge of release outcomes, creating a better understanding of species-specific challenges in reintroduction programs and enabling appropriate management of issues as they arise (Spinola et al., 2008). The post-release monitoring we implemented enabled us to adjust protocols as needed. In the early days, before they became adept at surviving using their own skills, the otters began to explore further away from the pre-release enclosure. Otters released in Sweden predominantly travelled in the first 10-15 weeks as they scouted for resources and established territories, where animals that dispersed farther distances from the release area suffered a greater number of human-related mortalities than those that remained closer to the site (Sjöåsen, 1996, 1997). To encourage the smooth-coated otters to remain close to the safe release site, we added a second supplementary feed. The additional food source has kept the otters in the remote area close to the pre-release enclosure, away from high human activity and visitor frequented areas.

The success of the release so far can also be attributed to the cooperation and investment into the reintroduction program by relevant authorities (APSARA), and the community. After the pup was caught in the illegal fishing trap, APSARA increased protection and removed remaining fishing equipment from the area. Community support similarly benefited the release of a smooth-coated otter in India, where fisherman provided post-release monitoring and *ad hoc* reports on the otter for 1.5 years after rehabilitators left the area (Dey et al., 2018). As with other species reintroduced as part of the rewilding program in Angkor, the release of otters has an additional conservation value for the remaining resident fauna with increased protection for the habitat and awareness from the local community.

Although resource-intensive, it is essential to implement IUCN recommended pre- and post-release protocols from an animal welfare and a conservation perspective, especially for captive-bred or rescued species that have spent extended periods in captivity. Indeed, it could be considered inhumane and a waste of resources to ignore such protocols. As populations of different species continue to decrease in the wild due to anthropogenic circumstances, the release of captive-born or rescued wild animals will become an increasingly important science. The documentation and dissemination of release outcomes is imperative to improve methodology so that reintroduction programs can contribute to the conservation of species.

We will continue to monitor and support the released otters for as long as necessary. The Angkor rewilding program between APSARA, FA and Wildlife Alliance, is being conducted on a step-by-step basis. As we have done with the pileated gibbons (*Hylobates pileatus*) we have released into Angkor, we hope to release a second pair of otters in a different location once we are sure the original animals can survive and after we have identified a suitable unrelated pair for release.

Acknowledgements - The authors would like to thank the following for their support with this work, without whom it could not have been implemented: Aspinall Foundation, Anderson-Rogers Foundation, Badreyyah Alireyza, Barbara Delano Foundation, New Forest Wildlife Park, ForPEACE, For the Animals, International Otter Survival Fund, Margot Marsh Biodiversity Foundation, Lorraine Parmer, Segre Foundation, USFWS, Wallace Research Foundation, Zoological Society of Hertfordshire. We would like to express our gratitude, respect and appreciation to APSARA and the Cambodian Forestry Administration. Their cooperation and support may help us to ensure a greater knowledge and understanding of humane release methods, so that reintroduction programs can complement other conservation initiatives being implemented in S.E. Asia and elsewhere. The authors thank the reviewers for their feedback and assistance in improving this document.

REFERENCES

Aadrean, A., Kanchanasaka, B., Heng, S., Reza Lubis, I., de Silva, P. Olsson, A. (2015). *Lutra sumatrana***.** The IUCN Red List of Threatened Species 2015: e.T12421A21936999. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T12421A21936999.en. Downloaded on 24 June 2020.

Batson, W.G., Gordon, I.J., Fletcher, D.B., Manning, A.D. (2015). Translocation tactics : a framework to support the IUCN Guidelines for wildlife translocations and improve the quality of applied methods. *J. App. Ecol*., **52**: 1598-1607.

Beck, B.B., Rapaport, L.G., Stanley Price, M.R., Wilson, A.C. (1994). Reintroduction of captive-born animals. In: **Olney, P.J., Mace, G.M., Feistner, A.T. (Eds.)**. Creative Conservation: Interactive management of wild and captive animals. Chapman & Hall, London, UK, pp. 265-286.

Bennetto, C. (2009). International training workshop on Asian otter research and conservation. *IUCN Otter Spec.Group Bull.* **26**(2): 113-125.

de Silva, P., Khan, W.A., Kanchanasaka, B., Reza Lubis, I., Feeroz, M.M. and Al-Sheikhly, O.F. (2015). *Lutrogale perspicillata*. The IUCN Red List of Threatened Species 2015: e.T12427A21934884. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T12427A21934884.en Downloaded on 08 April 2021.

Dey, S., Dey, S., Choudhary, S., Kelkar, N. (2018). On the rehabilitation of a hand-reared adult smooth-coated otter *Lutrogale perspicillata* in Bihar, India. *IUCN Otter Spec.Group Bull*. **35**(2): 71-84.

Duplaix, N., Savage, M. (2018). The Global Otter Conservation Strategy. IUCN/SSC Otter Specialist Group, Salem, Oregon, USA**.**

Gómez, J. R., Jorgenson, J., Valbuena, R. (1999). Report on the Rehabilitation and Release of Two Giant River Otter (*Pteronura brasiliensis*) Pups in the Bita River (Vichada, Colombia). *IUCN Otter Spec. Group Bull.* **16** (2): 86-89.

Gomez, L., Shepherd, C.R. (2019). Stronger International regulations and increased enforcement effort is needed to end the illegal trade in otters in Asia. *IUCN Otter Spec.Group Bull*. **36**(1): 71-76.

IUCN/SCC (1998). Guidelines for Re-introductions. Gland, Switzerland and Cambridge, UK.
IUCN/SCC (2013). Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland.
Johnson, S.A., Berkley, K.A. (1999). Restoring river otters in Indiana. *Wildl. Soc. Bull.* **27**(2): 419-427.
Jule, K.R., Leaver, L. A., Lea, S.E.G. (2008). The effects of captive experience on reintroduction survival in carnivores : A review and analysis. *Biol. Conserv.* **141**(2): 355–363.
Kleiman, D.G. (1989). Reintroduction of Captive Mammals for Conservation. *J. BioScience.* **39**(3): 152-161.
Kleiman, D.G., Beck, B.B. (1994). Criteria for reintroductions. In: **Olney, P.J., Mace, G.M., Feistner, A.T. (Eds.).** Creative Conservation: Interactive management of wild and captive animals. Chapman & Hall, London, UK, pp. 287-303.
Kleiman, Devra G., Beck, B., Dietz, J.M., Dietz, L.A. (1991). Costs of a re-introduction and criteria for success : Accounting and accountability in the Golden Lion Tamarin Conservation Program. *Symp. Zool. Soc.* **62**: 125-142.
Le Billon, P. (2000). The Political Ecology of Transition in Cambodia 1989 ± 1999 : War , Peace and Forest Exploitation. *Dev.Chang.* **31**: 785-805.
Leroux, N., Bunthoeun, R., Marx, N. (2019). The Reintroduction of Captive-born Pileated Gibbons (*Hylobates pileatus*) into the Angkor Protected Forest, Siem Reap, Cambodia. *Primate Conservation*, **33**: 11.
McTurk, D., Spelman, L. (2005). Hand-Rearing and Rehabilitation of Orphaned Wild Giant Otters , *Pteronura brasiliensis* , on the Rupununi River , South America. *Zoo Biol.* **24**:153-167.
Nicholson, T.E., Mayer, K.A., Staedler, M.M., Johnson, A.B. (2007). Effects of rearing methods on survival of released free-ranging juvenille southern sea otters. *Biol. Conserv.* **138**: 313-320.
Reading, R.P., Miller, B., Shepherdson, D. (2013). The Value of Enrichment to Reintroduction Success. *Zoo Biol.* **32**: 323-341.
Santiapillai, C. (2000). Threats to otters in Cambodia. *Biosphere Conserv.* **3**(1): 49–54.
Sjöåsen, T. (1997). Movements and establishment of reintroduced European otters *Lutra lutra*. *Brit. Ecol. Soc.* **34**(4): 1070-1080.
Sjöåsen, T. (1996). Survivorship of captive-bred and wild-caught reintroduced European otters *Lutra lutra* in Sweden. *Biol. Conserv.* **76**(2): 161-165.
Somers, M.J., Markus, G. (2009). The Role of Social Behaviour in Carnivore Reintroductions. **In:Hayward, M.W., Somers, M.J. (Eds.)** Reintroduction of Top-Order Predators. Blackwell Publishing Ltd., New Jersey, United States, pp. 270-281.
Spinola, R.M., Serfass, T.L., Brooks, R.P. (2008). Survival and Post-release Movements of River Otters Translocated to Western New York**.** *Northeast. Nat.*, **15**(1): 13-24.
Wright, L., de Silva, P., Chan, B., Reza Lubis, I. (2015). *Aonyx cinereus.* The IUCN Red List of Threatened Species 2015: e.T44166A21939068. https://dx.doi.org/10.2305/IUCN.UK.2015-2.RLTS.T44166A21939068.en. Downloaded on 24 June 2020.

RÉSUMÉ

SUIVI DU LACHÉ DE LOUTRES À PELAGE LISSE (*Lutrogale perspicillata*) DANS LE PARC ARCHÉOLOGIQUE D'ANGKOR, SIEM REAP, AU CAMBODGE

Une famille de loutres à pelage lisse (*Lutrogale perspicillata*) du Phnom Tamao Wildlife Rescue Center (PTWRC), Takeo, au Cambodge, a été réintroduite dans le parc archéologique d'Angkor, Siem Reap, au Cambodge, conformément aux directives de réintroduction de l'IUCN. Les protocoles comprenaient des enquêtes sur le site avant le lâché, la sélection des individus, des contrôles sanitaires, la réadaptation et l'apprentissage, suivis de l'acclimatation sur le site de lâché, d'une alimentation complémentaire après la libération et une surveillance quotidienne pour assurer la survie et le bien-être des loutres relâchées. La famille, composée d'un mâle, d'une femelle et de trois loutrons, a été transportée du PTWRC vers un enclos de libération préalablement préparé dans la forêt protégée entourant le parc archéologique d'Angkor pour l'acclimatation. Suite à la mort de deux loutrons en raison de la consommation d'œufs de crapaud venimeux dans l'enceinte de déconfinement, les trois loutres survivantes ont été libérées. Le juvénile restant a disparu environ trois semaines plus tard. Peu de temps après, le couple adulte a eu deux loutrons. Cette famille de quatre individus continue de survivre, six mois après leur remise en liberté.

RESUMEN

LIBERACIÓN MONITOREADA DE NUTRIAS LISAS (*Lutrogale Perspicillata*) EN EL PARQUE ARQUEOLÓGICO ANGKOR, SIEM REAP, CAMBOYA

Una familia de nutrias lisas (*Lutrogale perspicillata*) del Centro de Rescate de Fauna Silvestre Phnom Tamao (PTWRC), Takeo, Camboya, fue reintroducida en el Parque Arqueológico Angkor, Siem Reap, Camboya, siguiendo los Lineamientos de Reintroducción de UICN. Los protocolos incluyeron relevamientos de sitio pre-liberación, selección de animales candidatos, revisaciones sanitarias, rehabilitación y entrenamiento, seguido por aclimatación en el sitio de liberación, alimentación suplementaria post-liberación, y monitoreo diario para asegurar la supervivencia continua y el bienestar de las nutrias liberadas. La familia, compuesta por un macho, una hembra y tres crías, fue transportada desde el PTWRC a un recinto de liberación preparada, dentro del bosque protegido que rodea al Parque Arqueológico Angkor, para aclimatación. Luego de la muerte de dos crías debido a haber comido huevos de sapo venenoso dentro del recinto de pre-liberación, las tres nutrias sobrevivientes fueron liberadas. El juvenil desapareció aproximadamente tres semanas más tarde, y poco tiempo después la pareja adulta produjo dos crías. La familia de cuatro continúa sobreviviendo, habiendo pasado seis meses de su liberación.

មូលន័យសង្ខេប

ការត្រួតពិនិត្យតាមដានលើការដោះលែង ភេខ្លួនរលោង (*Lutrogale perspicillata*) ក្នុងឧទ្យានអង្គរ ខេត្តសៀមរាប ព្រះរាជាណាចក្រកម្ពុជា

គ្រួសារភេខ្លួនរលោង (*Lutrogale perspicillata*) មកពីមជ្ឈមណ្ឌលសង្គ្រោះសត្វព្រៃភ្នំតាម៉ៅ ខេត្តតាកែវ ព្រះរាជាណាចក្រកម្ពុជា ត្រូវបានបញ្ជូនទៅឧទ្យានអង្គរ ខេត្តសៀមរាប ព្រះរាជាណាចក្រកម្ពុជា ដោយអនុលោមតាមគោលការណ៍ណែនាំរបស់អង្គការសហភាពអន្តរជាតិដើម្បីអភិរក្សធម្មជាតិ (IUCN) ។ វិធីសាស្ត្រនៃការដោះលែងរួមមាន អង្កេតទីកន្លែងមុនដោះលែង ការជ្រើសរើសភេ ត្រួតពិនិត្យ តាមដានសុខភាព វិធីស្តារនីតិសម្បទា និងការបង្ហាត់ឲ្យរស់នៅតាមរបៀបធម្មជាតិ ដោយអនុលោមតាមការដាក់ឲ្យបន្សាំនៅទីតាំងមុនធ្វើការដោះលែង និងផ្តល់ចំណីបន្ថែមមុនដោះលែង ហើយធ្វើការតាមដានប្រចាំថ្ងៃដើម្បីឲ្យប្រាកដថា ពួកវាអាចរស់នៅបាន និងមានសុខភាពល្អ ចំពោះគ្រួសារភេដែលនឹងត្រូវដោះលែងនេះ។ ក្នុងគ្រួសារភេនេះ មានបាមួយក្បាល មេមួយក្បាល និងកូនៗចំនួនបីក្បាល ហើយត្រូវបានបញ្ជូនពីមជ្ឈមណ្ឌលសង្គ្រោះសត្វព្រៃភ្នំតាម៉ៅ ទៅទ្រុងដែលបម្រុងសម្រាប់ធ្វើការដោះលែង ហ៊ុមព័ទ្ធទៅដោយព្រៃការពារនៅឧទ្យានអង្គរ ដើម្បីធ្វើឲ្យពួកគេមានភាពបន្សាំនៅទីនោះ។ ជាអកុសលកូនភេចំនួនពីរក្បាលបានពុលស្លាប់ ដោយពួកវាបានស៊ីពងសត្វគីង្គក់ក្នុងទ្រុងមុនធ្វើការដោះលែង ហើយសត្វភេបីក្បាលទៀតដែលនៅសល់ត្រូវបានដោះលែង។ បន្ទាប់ពីដោះលែង ពួកវាបានបាត់ខ្លួនមួយរយៈ ហើយប្រហែលបីអាទិត្យក្រោយមក គ្រួសារភេនេះបានត្រឡប់មកវិញ មិនយូរប៉ុន្មានពួកវាបង្កើតបានកូនពីរបន្ថែមទៀត។ បន្ទាប់ពីដោះលែងរយៈពេលប្រាំមួយខែ គ្រួសារភេចំនួនបួនក្បាលនេះនៅតែបន្តរស់នៅក្នុងឧទ្យានអង្គរដដែល។

R E P O R T

DISTRIBUTION AND HUMAN-OTTER INTERACTION IN A MAN-MADE MTERA DAM: HOW FISHERS PERCEIVE THEIR NEIGHBOUR

Martin J. BAYO* and Alfan A. RIJA

Department of Wildlife Management, Sokoine University of Agriculture, P.O. Box 3073, Chuo Kikuu, Morogoro, Tanzania
**Corresponding author: Josephmartin592@gmail.com*

(Received 14th May 2020, accepted 25th October 2020)

Abstract: There is scarce information on the distribution of African clawless otter across many of its range habitats and how humans who mostly use similar resources perceive otters. This information gap precludes efforts to improve conservation of the otters especially in areas increasingly threatened by anthropogenic activities and habitat loss. We used local expert opinion assessment and field surveys as well as questionnaire to document the distribution of the African clawless otter and uncovered threats in the Mtera dam in central Tanzania. Our surveys detected otter presence in only 50% of the sites known by the local fishers in the area. More than 56% of the surveyed community were aware of the otter presence and reported four major threats faced by this carnivorous species including use of illegal fishing gears, overfishing, increased human population density that puts pressure on the land, water and fish resources and increased human habitation of the dam sides. These threats have the potential to drastically change the otter habitats and the ecosystem services offered by the dam with dire consequences to the human economy and food security. Improving conservation of the Mtera dam ecosystem is an increasing priority.

Citation: Bayo, M.J. and Rija, A.A. (2021). Distribution and Human-Otter Interaction in a Man-Made Mtera Dam: How Fishers perceive their Neighbour. *IUCN Otter Spec. Group Bull.* **38** (2): 95 - 105

Key words: Local perception; habitat threats; Mtera dam; otter hunting; species distribution

INTRODUCTION

The African clawless otter (*Aonyx capensis*) is a carnivorous small mammal species that inhabits semi-aquatic system where human activities are also common. Two (*Aonyx. capensis* and *Hydrictis maculicollis*) of the thirteen otter species known worldwide occur in lakes, rivers and wetlands in Tanzania (Foley et al. 2014). The populations of otters in many areas across Tanzania like many other countries, is less known due to limited studies. Information of otters from Tanzania is perhaps known from as few as five studies conducted in Lake Victoria by Kruuk and Goudswaard (1990), Reed-Smith et al. (2014), Amulike et al. (2013) and Stevens (2011) and recently by de Lucca et al. (2018) in southern Tanzania. There is no available information on the distribution of otters in other areas of Tanzania, despite the availability of many seemingly suitable habitats - a potential problem of conservation concerns for this predatory species. Elsewhere, studies have shown that otters across their range state are increasingly faced with threats from human persecution and loss of their habitats (Václavíková et al., 2011; Fonseca and

Marmontel, 2011; Ergete et al 2018; Akpona et al., 2015; Andarge et al., 2018). Other threats to otters include increased exploitation of their food base, accidental killing in nylon fishing nets, (Kruuk and Goudswaard, 1990), trapping for fur (Serfass et al., 2017), medicinal extraction for fetish as well expansion of agriculture in their habitat range (Rowe-Rowe, 1992; Václavíková et al., 2011; De Luca et al., 2018). These threats have led to most (i.e. 12 of the 13 species) otter species designated as threatened or endangered on the IUCN red list book (Jacques et al., 2015).

Conflicts arising from interactions between people and wild animals influence the future survival of many wild mammal species (Rija, 2017). Lack of awareness and species knowledge by local residents can threaten species survival through persecution, retaliatory killing, hunting or destruction of species habitats (Drew, 2005; Kideghesho et al., 2013). In most cases, the main cause of conflict appears to be the local people's perception of damage caused by otters to nylons nets together with a perception of prey depletion (fish, crabs and prawns) (Fonseca and Marmontel, 2012; Andarge et al., 2018). Like other animals, otters utilize habitat even those found outside protected areas. Hence, across the species' distributional range, non-charismatic and yet unprotected species such as the African clawless otter in Tanzania is likely to be exposed to various threat levels (Reed-Smith et al., 2014; Rija, 2017).

Although not well known by the general public, this mammal species is partially known by the fishermen in aspects that affect their livelihood such as feeding on netted fishes that would otherwise be available for the human consumption (Stevens, 2011; Václavíková et al., 2011; Amulike et al., 2013). This has always been the source of consequential killing of otters by the fishers during fishing occasions (Amulike et al., 2013; Andarge et al., 2018). Thus, understanding the knowledge of local people on the species they regularly interact with and how they perceive it may provide insights into the designing or improving of species conservation plans in the Mtera dam. This is particularly important especially during this time when the population of the clawless otter is continually decreasing with very little data on the presence and status of this species in its natural range habitats (Jacques et al., 2015). The current study was conducted to fill this information gap and to provide data for the African clawless otter inhabiting an increasingly contested Mtera dam ecosystem in central Tanzania. The aims of this study were; (i) to understand and document the current distribution of the African clawless otter in the dam ecosystem using local expert opinion and ground survey, and (ii) to assess the perception among humans about otters and dam use in order to further deduce conservation threats faced by the otter.

METHODS

Study area

Mtera dam is an impounded water dam along the Ruaha and Kisigo rivers located in central Tanzania (Lat 7°08′10.3″S and Long 35°59′12.6″E) between Dodoma and Iringa regions (Fig. 1). The dam measures 56 km long and 15 km wide and is used for hydropower generation (Yawson et al., 2003a). The dam is located in a semi- arid area receiving about 400 mm rainfall per year during November through to April (Yawson et al., 2003b).Temperatures range from 20 ^{o}C to 30 ^{o}C which provide suitable conditions for a spectacular wildlife species that range from large (e.g. Hippopotamus) to small aquatic mammals, e.g. the African clawless otter. Other wildlife species inhabiting the dam ecosystem include, crocodile, fish, birds and invertebrates. Plant life in this ecosystem is characteristic aquatic and terrestrial and some is riverine. The water dam is patched with some creeping species particularly *Glyceria maxima*, water hyacinth and water lilies. The banks on the other hand is grown with native tree species including *Adansonia digitata, Acacia tortilis* and Commiphora species which are characteristic of dry savanna landscapes. The soil is sandy and clay that supports agricultural activities around the dam.

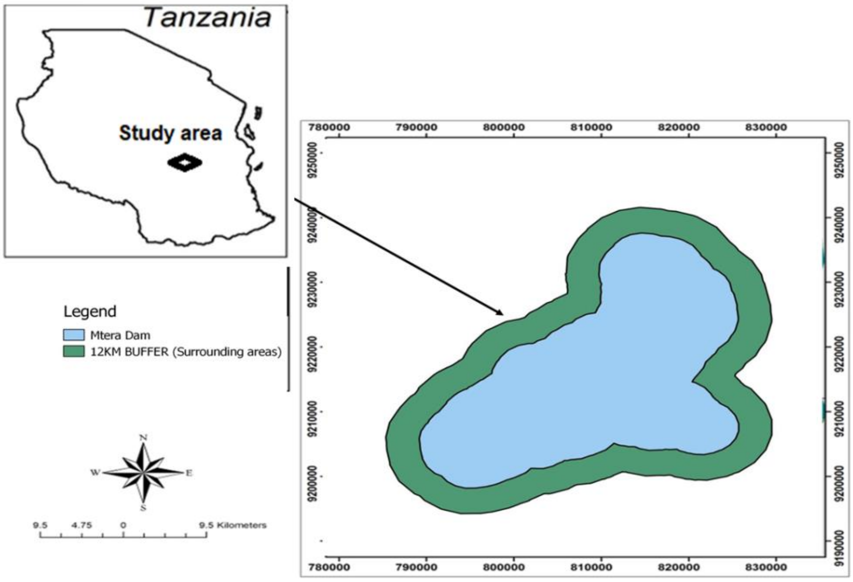


Figure 1. Location of the Mtera dam ecosystem in central Tanzania where this study was conducted.

The Mtera dam serves a large and growing needs of the surrounding human populations and is one of the hubs for generating hydropower that feeds electricity into the national power grid. The human population has grown by almost 350% over a decade (NBS, 2010; NBS, 2013) and looks set to increase further due to some pull factors related to the resources available such as the dam for fishing and fertile soil for agriculture and also due to the climate change- related stresses (Kideghesho et al., 2013). Most inhabitants are engaged in fishing from the dam and some in occasional crop farming and livestock grazing along the rivers. The farming and fish curing activities have over time degraded vegetation cover in the ecosystem and are cited to be causing siltation in the Mtera dam (Yawson et al., 2006). Siltation affects the habitat and food base of the carnivorous African clawless otter that inhabits the dam.

Data collection and analysis

In order to assess the occurrence of otters in the area, we first conducted expert opinion assessment among a local fisher community who regularly use the dam and potentially encounter the otter. This method is appropriate in assessing relative abundance of some rare species and has been used to assess other wild mammal abundance in hunting terrestrial system (van der Hoeven et al., 2004). To verify the type of otter species found in the study area, we used the Sub-Saharan Otter standard ID sheet from African otter network (AON). The sheet has three coloured images of otters i.e. African clawless otter, spotted necked otter and water mongoose and was attached to the questionnaires to allow local experts to identify the animals present in our study area. The target respondents were asked to identify the species based on their experience of wht they know of the animal in question, choosing one of the images of animals presented to them. Further, to map where the otter occurs in the dam ecosystem, and to confirm information collected from the local experts, we conducted a boat survey (10 km) and 3 km of walk transect along the dam banks (covering 50 meters wide off shore), to ground-truth and record presence or absence of the otter as suggested by the local experts. During survey, otter distribution and species ID was documented by recording animal spraints recognized for their size and shape and also as 'latrine' depending on whether the scats were found together (De Luca et al. 2018). The survey was carried out both during day (to look for otters and signs of their presence) and night (to look for active individuals) using night vision googles. A total of 24 man-hours per transect for 5 days during the night and 2 days during daytime was used when conducting the ground walk transect.

Further, to understand how the local human population perceives otter presence in the area, a questionnaire survey with 150 respondents from six villages was conducted. The surveyed villages and respondents were selected deliberately, based on proximity, access and occupation in the target area (Kothari, 2012; Etikan et al., 2016). A simple random sampling was used to obtain a sample of the population, mainly fishers and crop growers, for the survey. The questionnaire had several questions concerning whether a respondent has ever seen an otter before in the area, main activities engaged in, types of fishing gear (for fishers) and type of crop farming system (for agrarians), any problems with otters in their daily life activities, how they generally perceived the otter and what do they do to mitigate otter-associated problems.

The collected information was analysed mostly descriptively and information from local expert opinion assessment and surveys was processed using GIS tools - mainly plotting maps to display the distribution of otters.

RESULTS AND DISCUSSION

Distribution of African Clawless Otter in the Mtera Dam

Local experts identified ten sites thought to be occupied by the otter in the Mtera dam ecosystem (Fig. 2). These sites were inside the dam, but a few were outside the water. Our survey confirmed otters in only five of the mentioned sites thought to have otters (Fig. 3).

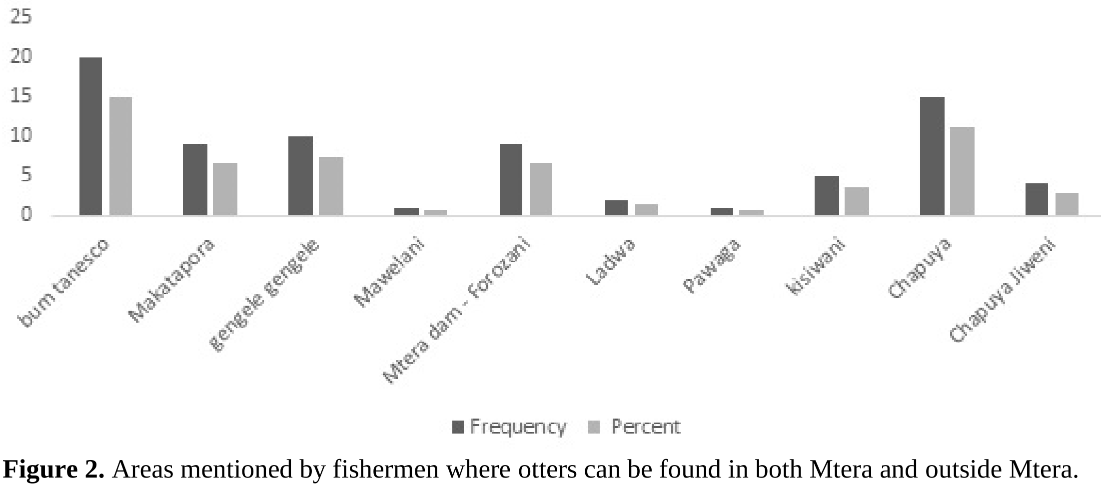


Figure 2. Areas mentioned by fishermen where otters can be found in both Mtera and outside Mtera.

The information collected through local expert opinion assessment was useful in helping the search process during actual field surveys. Although the survey was able to confirm only about 50% of the suggested sites for otters, this may not invalidate the knowledge from the local experts. This is because fishers and crop growers have lived the areas for most of their life, conducting activities that potentially lead to encountering with the otters, thus they are the most knowledgeable about the system. Human activities such as fishing directly lead to interaction between fisher and otter because they both depend on the same resource (i.e. fish) for food. For example, local experts were able to clearly point out otter territories because these same sites were the targets for the fishers to set the fishing nets. Not detecting otters in all the sites on the other hand may have been due to the short time spent in surveys which probably did not coincide with the peak activity of the otters. Therefore, more search effort could, probably, have increased chances for sighting the otter in the target sites. Our use of local expert opinion is not uncommon approach in conservation studies. In Cameroon, van der Hoeven et al. (2004) used local expert assessment to estimate density of wildlife in forest habitats. This method was rapid and saved time and money, and thus has been advocated for use especially in animal assessment where detection is potentially low (van der Hoeven et al., 2004). Our target species is nocturnal and rarely comes out for feeding during daytime, thus the use of fishers during local expert opinion assessment was appropriate as they have a great chance of interacting with the species during the fishing activities.

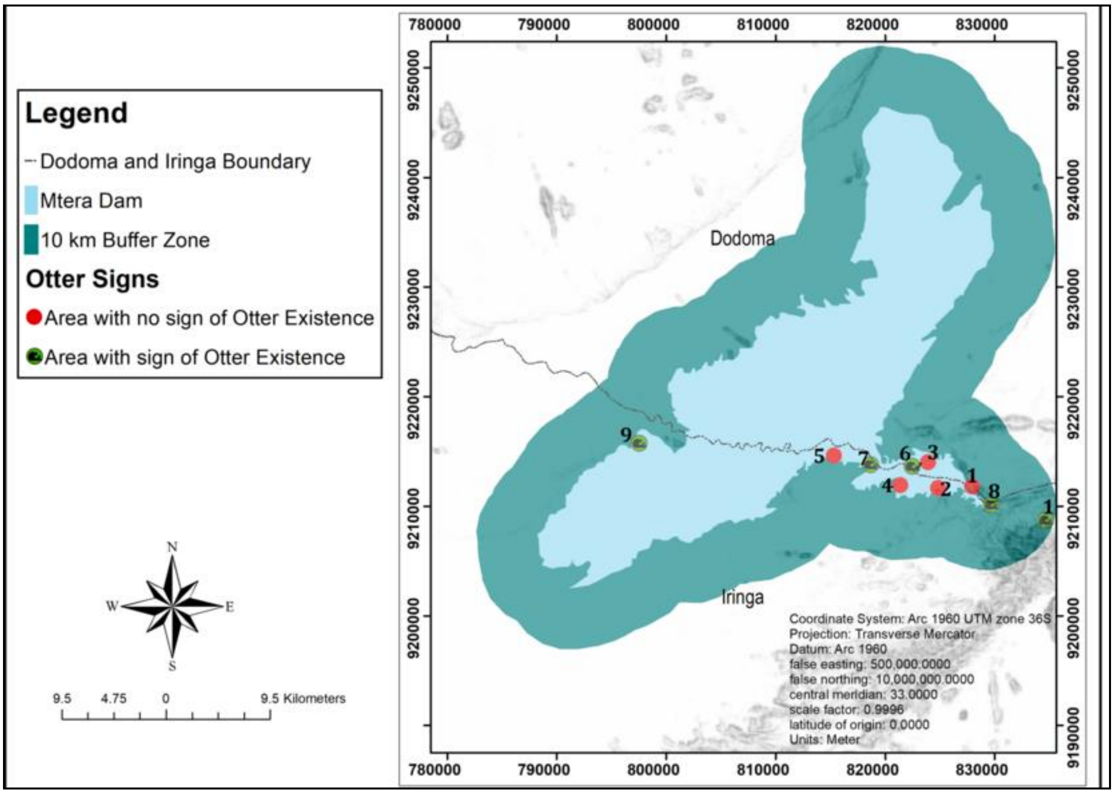


Figure 3. Distribution of otter showing the actual ground truthing on the area perceived by fishers to harbor otters in the Mtera dam. Numbers 1= Mtera dam-forozani, 2. Ladwa, 3. Island (kisiwani camp), 4, Makatapora, 5. Chapuya jiweni, 6. Mawelani, 7. Chapuya, 8. Bum Tanesco, 9. Pawaga, 10. Gengele gengele.

Our boat and transect walk surveys revealed otter existence was restricted to only a few areas. We detected six individuals of African clawless otter during boat surveys and several scats of roundish shape or egg-chop like shape. The scats were mostly dominated by fish scales and fins (Table 1).

An alternative explanation to our detection of otters from only 50% of the sites is that some of the suggested sites could be used less by the otters, perhaps due to deterioration of the habitat quality in the dam. During both questionnaire and transect surveys, our field observations recorded considerable stream bank agricultural activities, litter pollution and scattered growing water weeds in the dam (Fig 4 - panel photos of litter, water weeds and farms at the dam banks). Supporting these observations, the local communities and some dam authorities mentioned several problems including increased dam siltation and overfishing as potential threats to the habitats and the survival of the African clawless otter.

Table 1. Individual otter and otter scats sighted in various localities within the Mtera dam ecosystem during boat and transect walks. Fish scales and fins composed most scats found during the surveys suggesting that fish was the major food resource used by the African clawless otter in the study area.

Site Name	What Found / Seen	Condition / Activity	Scat Content	Transect Type
Gengele	6 Scats	Dry	Fish fins and scales	Walking
Gengele	3 Scats	Wet	Fish fins and scales	Walking
Gengele	8 Scats	Dry	Fish fins and scales	Walking
Gengele	1 Individual	Swimming		Boat
Makatapora	1 Individual	Resting		Boat
Gengele	13 Scats	Both dry and wet	Fish fins and scales	Walking
Gengele	7 Scats	Dry	Fish fins and scales	Walking
Chapuya	3 Scats	Dry	Fish fins and scales	Walking
Bum Tanesco	4 Individuals	Swimming		Boat
Pawaga	12 Scats	Dry	Fish fins and scales	Walking

Figure 4. Photographs captured in the study area during field data collection showing various potential threats to the otter habitat. A = Livestock grazing and human use of water in Mtera dam, B = Crop farm along a stream that feeds the dam, and C = Plastic and other litter refuse scattered along the dam. (photographs by Martin Bayo collected on Sept 9, 2018)

Human perception of and threats to otters in the dam

The question of human perception of otters in the study area revealed various responses. About 56% of respondents (N=140) replied that they knew about otter presence in the area and about 28% of the local communities had directly interacted with otters through hunting otters for meat and body parts for fetish (Table 2). Also, humans interacted with otters during fishing as they competed for similar fish food resources, and this interaction was perceived to be a substantial potential source of human-otter conflict as otters sometimes got entangled in fishing nets and were killed as a result by the fishers. Asking the types of threats that people thought negatively affected otter population in the area, several scores were given (Table 2). Four threats were recognized and highly ranked including use of illegal fishing gears, overfishing, human population increase in Mtera and increased human habitation of the dam sides (Fig. 5). Other threats that were perceived to be affecting the otter population were increased water pollution, otter hunting and expanding agriculture.

Understanding human perception of a species is an important avenue for assessing the conservation status of a species and potential threats to it in a particular area. Our finding that more than 50% of the surveyed human population were aware of the presence of otter in the area is encouraging, as this may suggest that any conservation efforts for otters that involve awareness raising may be conducted with relative ease. This argument stems from the fact that if local communities already know about a species and its importance, they are likely to align well with conservation measures (Kidegheshо et al., 2013).

Table 2. Fishermen perceptions about the potential threats to the African clawless otter in the Mtera dam ecosystem. Illegal use of fishing gears, human population increase, stream-side cultivation, and lack of awareness about otters and conservation were the most and highly ranked threats in the study area.

Potential threats	**Percentage (%) Likert scale ranking, (N= 140)**				
Questions on human-otter interaction and threats	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Has water pollution decreased population of otters?	36.30	14.50	15.30	16.10	17.70
Has high fishing activity negatively affected otter population?	12.0	13.60	14.40	35.20	24.80
Has use of illegal fishing gear decreased population of otter in the dam?	10.30	8.70	11.90	31.0	38.10
Has increasing human population around the dam decreased population of the otter?	22.20	9.50	13.50	23	31.70
Have agriculture activities contributed to increased otter decline?	48.80	18.40	13.60	9.60	9.60
Has lack of awareness of this animal contgribuled to species decline?	24.0	10.40	8.0	16.80	40.80
Has cultural use of otter increased hunting in the area?	39.80	13.0	18.70	12.20	16.30
Has human occupation of shoreline areas increased threat impact to otters?	25.0	10.50	10.50	28.20	25.80

Furthermore, the local perception of the existing threats and their severity to the otter population is important information for any conservation improvement plan. However, the use of illegal fishing gear and perceived overfishing are of high concern for the survival and conservation of otters in the area. Illegal use of unsustainable fishing gear, such as fish seine nets and poison, remove massive amounts of the fish population, reducing fish survival and recruitment, and directly diminishing the food base for the otters. Reduced fish stock in the dam may further exacerbate fish resource competition between the fishers and otters. Furthermore, the hunting of otters for meat and body parts directly reduces the population in the area, while increased human habitation along the dam and expanding agricultural activities add silt into the dam. Siltation has the potential to significantly reduce the depth of the dam, reducing the breeding habitat for fish and thus the potential food resources available for the otter population. Altogether, these threats will have far reaching impacts on the long-term survival of this least conserved aquatic carnivore in Tanzania.

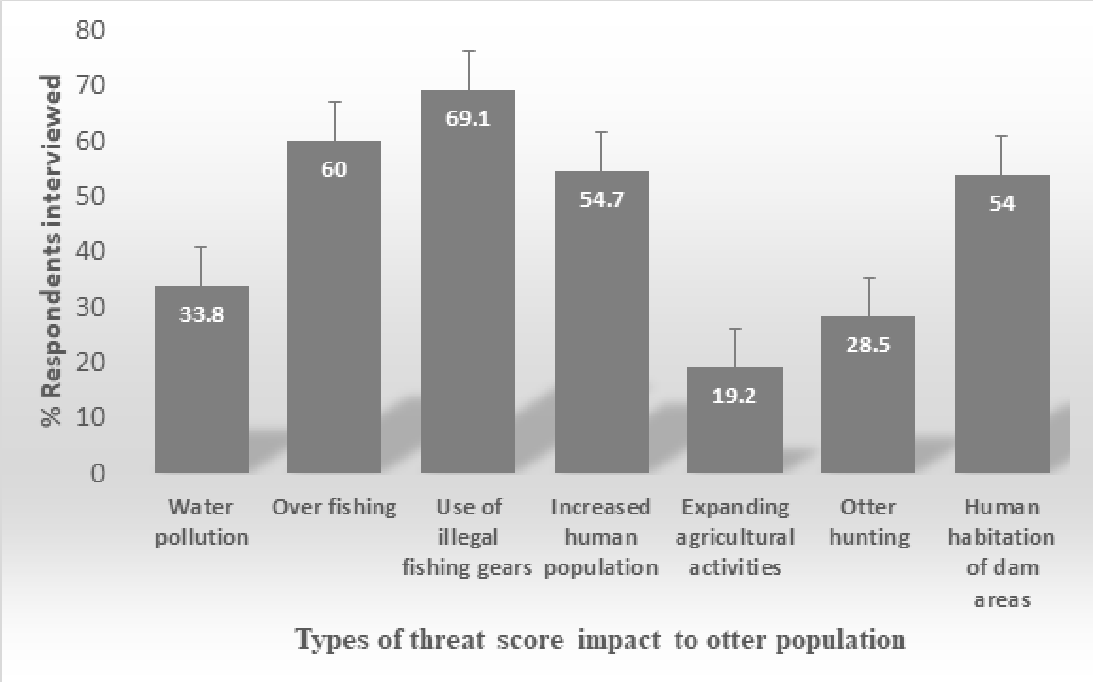


Figure 5. Scores of effects of various types of threats to the otter population as perceived by the local communities living in the Mtera dam ecosystem. Error bars indicate standard deviation (SD) on the percent mean scores for each threat.

The implications of these data are far reaching, both for the conservation of the otter and its habitat, and for human food security. Firstly, the distribution of the African clawless otter in the Mtera dam ecosystem appears to be declining, as pointed out by the surveyed local fisher community, probably due to the identified threats in the area. While our search efforts found that about 50% of all the sites originally known by the local communities to have otters were now negative, we are not sure whether additional sampling effort could have added more positive sites. We are tempted to argue that the range of otter has indeed declined. However, we caution that longer time research is needed to confirm our initial observations. Also, we suggest that long-term monitoring of otter population is urgently needed in the area for planning to alleviate potential drastic decline of the population and imminent local extirpation resulting from increasing anthropogenic activities. Use of illegal fishing gear and overfishing fall within the dam management capability and could be regulated through law enforcement and introduction of some zoning schemes to regulate potential overfishing impacts. It is recommended that the dam management authority under Tanzania Electricity Supply Corporation (TANESCO), in collaboration with the local government fishery authority in the area, should set up a monitoring unit that would oversee conservation efforts in the area. Such a unit would be responsible for monitoring human activities in the area such as agriculture, water use, hunting of otter and other wild animals and the sprawl of human habitation impacts near the dam.

Secondly, the use of the resources in the dam ecosystem is important for ensuring food security for the growing human population in the area. The local communities heavily depend on the land, water and fish resources for producing food crops, drinking water and fish protein food. As urbanization and human population growth increase in the area, pressures on these resources will increase and will likely squeeze the population of the African clawless otters towards local extirpation (Rija et al., 2014). The fish landed from the Mtera dam is traded in many regions of central and eastern Tanzania especially in Dodoma, Morogoro and Dar es Salaam, thus contributing substantially to the local economy and food security of many people in these regions. Human population increasing in this region will increase fish demand, thus increasing fishing pressure in the Mtera dam. This will further reduce the food base for the clawless otter. There is, thus, an urgent need for some measures to be put in place to ensure sustainability of the resources used. One way to make this happen is to raise awareness about this species and conservation of the habitats among a wider community, including conservation agencies, e.g. Tanzania Wildlife Authority (TAWA), and policy makers, e.g. the Wildlife Division in Tanzania, so that informed decisions on the conservation of the whole dam watershed ecosystem can be made. Reaching the wider community could be possible through popular media such as local newspapers, which have been found to be an important avenue for communicating biodiversity and conservation information locally (Rija and Kideghesho, 2020). Striking this balance will also ensure longer-term survival of the African clawless otter which depends on the water and fish resources in the increasingly contested Mtera dam.

Acknowledgements - This study benefited financial support from the Rufford Small Grant Foundation through Grant # 25815-1 to the first author. We thank Jan Reed Smith for providing us with Sub Saharan otter's standard ID sheet as aid to guide the surveyed respondents to correctly ID the clawless otter. Dr. John Mgonja, Dr. Sayuni Mariki and Dr. Nsajigwa Mbije for their technical assistance during data collection. Two field assistants, Madata Mlinago and Joel Pesha for their help during data collection in the field and anonymous reviewers for the comments to this manuscript.

REFERENCES

Akpona, A.H., Djagoun, C.A.M.S., Harrington, L.A., Kabré, A.T., Mensah, G.A., Sinsin, B. (2015). Conflict between spotted-necked Otters and fishermen in Hlan River, Benin. *Journal for Nature Conservation*, **27**: 63-71.

Amulike, B., Stevens, S.S., Serfass, T.L. (2013). Enhancing tourist opportunities to view spotted-necked otters (*Lutra maculicollis*) at Rubondo Island National Park: can the a priori location of latrines simplify identifying best viewing areas? *Afr. J. Ecol* **51** :609-617.

Andarge, E., Wube, T., Balakrishnan, M., Serfass, T.L. (2018). Fishermen knowledge and conflict with African clawless otter in and around Lake Tana, Ethiopia. *Afr. J. Ecol* **56**: 409-313

De Luca, D.W., Dewas, M., Mpunga, N., Machaga, S.J., Phillipps, G.P. (2018). The conservation status of otters in Southwest Tanzania. *IUCN Otter Specialist Group Bulletin*, ***35*** (3): 134-147.

Drew, J.A. (2005). Use of Traditional Ecological Knowledge in Marine Conservation. *Conservation Biology*, **19**: 1286-1293. https://doi.org/10.1111/j.1523-1739.2005.00158.x

Ergete, E.A. Hailemariam, T.W., Balakrishnan, M., Serfass, T.L. (2018). Fishermen knowledge and conflict with African Clawless Otters in and around Lake Tana, Ethiopia. *Afr. J. Ecol*, **56**: 409-413.

Etikan, I., Musa, S.A. Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, **5**: 1-4.

Foley, C., Foley, L., Lobora, A., De Luca, D., Msuha, M., Davenport, T.R., Durant, S.M. (2014). A field guide to the larger mammals of Tanzania (Vol. 90). Princeton University Press.

Fonseca, V., Marmontel, M. (2011). Local knowledge and conflicts with Otters in western Brazilian Amazon: a preliminary report. *IUCN Otter Spec. Group Bulletin*, **28**(B): 64 - 68.

Jacques H., Reed-Smith J., Somers M. (2015). *Aonyx capensis*. The IUCN Red List of Threatened Species 2015. http://dx.doi.org/10.2305/IUCN.UK.2015- 2. RLTS.T1793A21938767.en

Kideghesho, J.R., Rija, A.A., Mwamende, K.A., Selemani, I.S. (2013). Emerging issues and challenges in conservation of biodiversity in the rangelands of Tanzania. *Nature Conservation* **6**: 1-29.

Kothari, C.R. (2012). Research methodology: An introduction. Research Methodology: Methods and Techniques, 9, 418. Chicago

Kruuk H., Goudswaard, P.C. (1990). Effects of changes in fish populations in Lake Victoria on the food of Otters (*Lutra maculicollis* Schinz) and (*Aonyx capensis* Lichtenstein). *Afr. J. Ecol.* **28***: 322-329.*

National Bureau of Statistics (NBS) [Tanzania]. (2010). Population projections. (2010). Dar es Salaam,Tanzania: NBS.

National Bureau of Statistics (NBS) and Office of Chief Government Statistician (OCGS). (2013). 2012 Population and Housing Census: Population Distribution by Administrative Units; Key Findings. Dar es Salaam, Tanzania: NBS and OCGS

Reed-Smith, J, T. Serfass, T. Kihudu, and M. Mussa. (2014). Preliminary report on the behavior of spotted-necked otter (*Lutra maculicollis*, Lichtenstein, 1835) living in a lentic ecosystem. *Zoo Biology* **33**: 121-130.

Rija, A.A. (2017). Spatial Pattern of Illegal Activities and the Impact on Wildlife Populations in Protected Areas in the Serengeti Ecosystem. PhD thesis, University of York, U.K. http://etheses.whiterose.ac.uk/id/eprint/20276

Rija, AA. Said, A., Mwamende, K.A. Hassan, S.N., Madoffe, S.S. (2014). Urban sprawl and species movement may decimate natural plant diversity in an Afro-tropical city. *Biodiversity and Conservation* **23**(4): 963-978.

Rija, A.A., Kideghesho, J.R. (2020). The Coverage of Biodiversity Conservation Issues in Local Newspapers and Its Role in Enhancing Conservation Awareness in Tanzania: An Analysis of Two News Outlets. *Archiv Zool Stud*., **3**: 013

Rowe-Rowe, D.T. (1992). Survey of South African otters in a freshwater habitat, using sign. *South African Journal of Wildlife Research*. **22**: 49-55.

Serfass, T.L., Wright, L., Pearce, K., Duplaix, N. (2017). Animal welfare issues pertaining to the trapping of otters for research, conservation, and fur. In *Marine Mammal Welfare* (pp. 543-571). Springer, Cham.

Stevens, S.S. (2011). Flagship species, tourism, and support for Rubondo Island National Park, Tanzania.

Václavíková, M., Václavík, T., Kostkan, V. (2011). Otters vs. fishermen: Stakeholders' perceptions of Otter predation and damage compensation in the Czech Republic. *Journal for Nature Conservation*, **19**: 95-102.

Van der Hoeven, C.A., de Boer, W.F., Prins, H.H. (2004). Pooling local expert opinions for estimating mammal densities in tropical rainforests. *Journal for nature conservation*, **12**: 193-204.

Yawson, D.K., Kashaigili, J.J., Kachroo, R.K., Mtalo, F.W. (2003). Modelling the Mtera Kidatu Reservoir System to improve Integrated Water Resources Management. International Conference on Hydropower (Hydro Africa 2003), 17th-19th Nov. 2003, Arusha, Tanzania.

Yawson, D.K., Kachroo, R.K., Kashaigili, J.J. (2003). Failure of the Mtera-Kidatu reservoir system in the Early 1990s. Paper Presented at Ruaha+10 Seminar, 11 & 12 December 2003, Morogoro, Tanzania. 12 pp. (paper) + 3 pp. (powerpoint)

Yawson, D.K., Kongo, V.M., Kachroo, R.K. (2006). Impact assessment of Mtera and Kidatu reservoirs on the annual maximum floods at Stiegler's Gorge of the Rufiji River in Tanzania. *Water International*, **31**: 100-108.

Zlatanova, D.P. Popova, E.D. (2018). Biodiversity estimates from different camera trap surveys: a case study from Osogovo Mt., Bulgaria. *Nature Conservation Research.* **3**: 13-25.

RÉSUMÉ

DISTRIBUTION ET INTERACTION ENTRE L'HOMME ET LA LOUTRE À JOUES BLANCHES (*Aonyx capensis*) AU BARRAGE ARTIFICIEL DE MTERA: COMMENT LES PÊCHEURS PERÇOIVENT-ILS LEUR VOISIN ?

Il existe peu d'informations sur la répartition de la loutre à joues blanches (*Aonyx capensis*) dans plusieurs de ses habitats de prédilection et sur la façon dont l'homme, qui utilise principalement des ressources similaires, perçoit la loutre. Ce manque d'informations nuit aux efforts visant à améliorer la protection des loutres, en particulier dans les zones de plus en plus menacées par les activités anthropiques et la régression de l'habitat. Nous avons utilisé une enquête d'opinion d'experts locaux et des relevés de terrain ainsi qu'un questionnaire destiné évaluer la distribution de la loutre à joues blanches et mettre en évidence les menaces qui pèsent sur le barrage de Mtera, situé dans centre de la Tanzanie. Nos enquêtes ont mis en évidence la présence de loutres dans seulement 50% des sites connus par les pêcheurs locaux de la région. Plus de 56% de la communauté étudiée étaient au courant de la présence de la loutre et ont signalé quatre menaces majeures auxquelles cette espèce carnivore est confrontée, notamment par l'utilisation d'engins de pêche illégaux, la surpêche, l'augmentation de la densité de la population humaine qui exerce une pression sur les terres, l'eau et les ressources halieutiques et une augmentation de l'urbanisation sur les rives du barrage. Ces menaces peuvent potentiellement changer de manière radicale les habitats de la loutre et les bienfaits de l'écosystème que procure le barrage, avec des conséquences désastreuses pour l'économie humaine et la sécurité alimentaire. L'amélioration de la conservation de l'écosystème du barrage de Mtera est une priorité croissante.

RESUMEN

DISTRIBUCIÓN E INTERACCIÓN HUMANOS-NUTRIAS EN LA REPRESA MTERA, TANZANIA: CÓMO PERCIBEN LOS PESCADORES A SU VECINO

Existe muy poca información sobre la nutria sin garras Africana a lo largo de su rango de distribución y de sus hábitats preferidos además de cómo los humanos perciben a esta especie. Esta carencia de información previene esfuerzos de conservación de las nutrias que están cada día mas amenazadas de extinción debido a la persecución humana y la pérdida de hábitat. En este estudio usamos la opinión de expertos y recorridos en campo así como cuestionarios para documentar la distribución de la nutria sin garras Africana en la región de la presa Mtera en centro de Tanzania. Nuestros recorridos en campo detectaron la nutria en solamente 50% de los sitios conocidos por los pescadores del área. Mas del 56 % de los encuestados habían visto las nutrias y conocían su presencia en la región. Los encuestados reportaron cuatro amenazas mayores para esta especie de carnívoro, el uso de artes de pesca ilegales, la sobrepesca, un incremento en la densidad humana que presiona los recursos del agua, la tierra y la pesca y un incremento en uso de los lados de la presa como áreas urbanas. Esas amenazas tiene el potencial de cambiar drásticamente el hábitat que utiliza la nutria y modificar los servicios ecosistémicos ofrecidos por la presa con consecuencias para la economía humana y la seguridad alimentaria. Mejorara la conservación del ecosistema de la presa Mtera es una prioridad

A R T I C L E

RELATIONSHIP BETWEEN TEMPORAL ENVIRONMENT FACTORS AND DIET COMPOSITION OF SMALL-CLAWED OTTER (*Aonyx cinereus*) IN HETEROGENEOUS PADDY FIELDS LANDSCAPE IN SUMATRA, INDONESIA

Ferdi ANDESKA, Wilson NOVARINO, Jabang NURDIN, AADREAN*

Biology Department of Andalas University, West Sumatra, Indonesia
**e-mail: aadrean@sci.unand.ac.id*

(Received 24th August 2020, accepted 28th October 2020)

Abstract: The small-clawed otter (*Aonyx cinereus*) is one of four otter species in Indonesia. This species consumes various types of animals. The availability of prey animal depends on its environmental conditions. Therefore, this study aimed to examine relationship between temporal environmental factors and diet composition of the small-clawed otter in paddy field landscape. We examined 415 spraints collected from a heterogeneous paddy field landscape in West Sumatra, Indonesia. We found that small-clawed otter consumed fishes, snails, crabs, reptiles, frogs, birds, and mammals. Unlike in the natural habitat, fish became the dominant diet rather than crabs. Furthermore, we performed generalized linear model (GLM) analysis to explain the temporal environmental factors that affect composition of small-clawed otter's diet. GLM analyses revealed that temperature, rainfall, water level and cultivation stage were not significantly related to fish composition in small-clawed otter diet. Water level showed positive relationship to snails in the diet composition. Temperature showed positive relationship to both insect and frogs in the diet composition.

Keywords: Generalized Linear Model, Paddy field cultivation stage, Score-Bulk estimate, Opportunist predator

INTRODUCTION

The small-clawed otter (*Aonyx cinereus*) is one of four otter species in Indonesia. The small-clawed otter is adapted to the tropical climates of South and Southeast Asia (Melisch et al., 1994). This species can be found in freshwater and brackish water, including swamp forests, rice fields, lakes, streams, reservoirs, waterways, mangroves, and along the coast (Sivasothi and Nor, 1994). The small-clawed otter is listed in The International Union for Conversation of Nature's Red List as a Vulnerable animal. (Wright et al., 2015). Since November 2019, the status of the small clawed otter in CITES is upgraded from Appendix II to Appendix I (Okamoto et al., 2020).

Small-clawed otters consume various types of animals: fish, crabs, molluscs, amphibians, insects, reptiles, birds, and mammals (Foster-Turley, 1992; Kruuk et al., 1994; Anoop and Hussain, 2005; Hon et al., 2010; Aadrean et al., 2011). In their natural habitat, the small-clawed otter prefers to eat crabs rather than other aquatic animals (Kruuk et al., 1994; Hon et al., 2010).

The availability of prey species in a habitat is a main factor influencing prey selection (De Silva, 1991). In addition, geographical factors such as latitude, altitude, and climate determine the eating habits of a species (Remonti et al., 2009). Variations in food resources can influence the selection of animal habitats (Wang et al., 2010). Research on diet composition can provide an overview of animal ecological niches and help to design strategies in conservation management in a landscape (Kruuk, 2006). Furthermore, a landscape has a spatio-temporal dynamic that influences the ecological interaction of the organisms. However, previous studies on small-clawed otter diet composition have not yet revealed information on its relationship to temporal environmental factors (Kruuk et al., 1994; Hon et al., 2010; Foster Turley, 1992; Kanchasanaka and Duplaix, 2011; Aadrean et al., 2011; Abdul Patah et al., 2014).

The existence of small-clawed otters in the paddy fields of West Sumatra had been reported by Aadrean et al., (2010). Paddy fields are an inundated aquatic ecosystem that supports various types of aquatic animals (Che Salmah et al., 2017). Paddy ecosystems have a high diversity of fauna. This diversity is largely determined by the environmental conditions of the rice fields (Heong et al., 1991). In addition, Aadrean and Usio (2017; 2020) have also described the characteristics of latrine site of small-clawed otters in the West Sumatra paddy field and its relationship to environmental factors. However, the research did not report on diet composition of small-clawed otter, and its relationship to temporal environmental factors. The purpose of this study, therefore, was to determine the effect of environmental factors of paddy on the diet of small- clawed otters.

STUDY SITE AND METHOD

Study site

We studied small-clawed otters in paddy fields in Lubuk Alung sub-district, Padang Pariaman Regency, West Sumatra, Indonesia (00°38'00"S – 00°40'40"S, 100°17'10" – 100°20'20" E, with altitude 25 – 50 m above sea level) (Fig. 1). The paddy field landscape has an area of 3.139 Ha, with most of them (2.815 Ha) irrigated with technical irrigation from the Anai Dam irrigation project. This area has a tropical climate. Rainfall in Lubuk Alung has a range of 138 – 853.2 mm/month, with an average of 558.225 mm/month (Statistics Indonesia, 2013-2017).

The paddy fields in this study were owned and managed by individuals or small groups of farmers. Paddy cultivation in the study site can take place two or three times per year. Because there is no great fluctuations in climate conditions, and thertr is all-day availability of water from the Anai Dam, farmers may determine for themselves when to plant rice in their paddy fields. As a result, the paddy cultivation stage was asynchronous, creating heterogeneous paddy field landscape.

Otter Diet

We examined 415 spraints collected from the Lubuk Alung paddy field from March 2015 to April 2017. The spraints were collected weekly from 25 latrine sites recorded during a previous study (Aadrean and Usio, 2017), which investigated latrine site characteristics and visitation rates. While collecting each spraint specimen, Aadrean and Usio (2017) recorded rice cultivation stage and water level of the paddy field adjacent to the latrine site. Prior to identification, the spraints were washed in water and then air-dried.

For identification, we used reference material created from prey species collected in the study site.

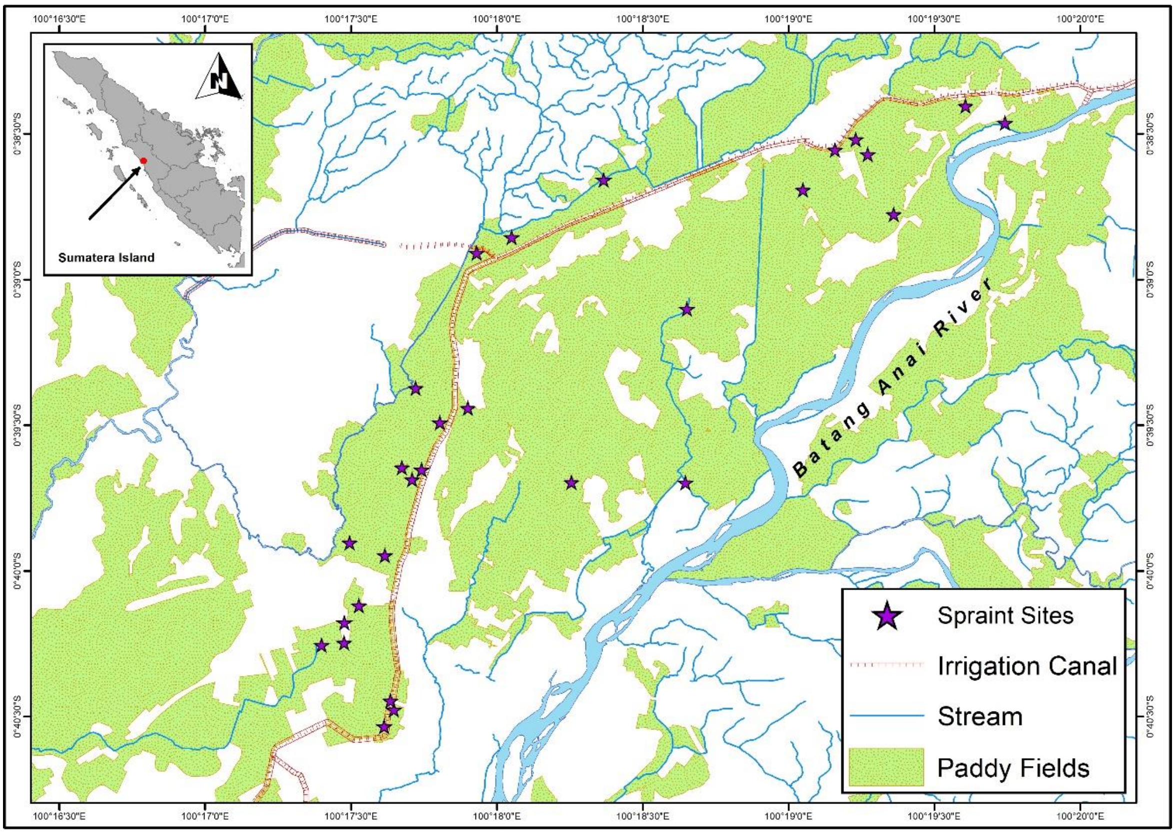


Figure 1. Map of the study site in West Sumatra

Data Analysis

Diet composition was analyzed by occurrence frequency, relative occurrence frequency (Anoop and Hussain, 2005) and *Score-Bulk Estimate* (SBE) (Fonseca et al., 2008). Then to conclude, we used the *Rescaled Important Index* (RII) proposed by Fonseca et al., (2008). Scores of SBE were obtained by multiplying the dry weight of the spraint with the visual proportion value (ranged from 1 to 10) of each prey animal category.

To reveal any relationship between temporal environmental factors and diet composition, we performed statistical modeling. We used the SBE of each diet composition category for response variable (Table 1). We only selected prey categories that had an occurrence frequency of more than 10% (fishes, molluscs, insects and frogs). We used cultivation stage, water level of paddy fields, temperature and rainfall as predictor variables. The temperature and rainfall data were obtained from Meteorological, Climatological, and Geophysical Agency (BMKG) data extracted from annual profile of Padang Pariaman regency (Statistics Indonesia, 2016-2018). Cultivation stage wase divided into 4 categories: preparation, vegetative, generative, and postharvest. Preparation stage is the period starting from when paddy fields are ploughed until the farmers plant the rice seedlings. Vegetative stage is the period from farmers starting to plant rice until the emergence of the paddy flowers. Generative stage starts from the period of flowering until farmers harvest the rice. Postharvest is when the period after harvesting until the fields are ploughed again.

We examined the relationship in two levels of model; spraint site level and landscape level. In spraint site level, we used diet composition of each spraint specimen. In landscape level, we pooled diet composition of spraints that were collected from each weekly sampling effort. Thus, we averaged the SBE and other environmental factors, except for cultivation stage, where we used dominant stage as the input data (Table 2).

Table 1. Response variables used in the GLM models

Prey Item	Model Type	Data Summary (min – max; average±SD)
Fishes	Spraint site level	Range 0.00 – 35.00; Average 13.65 ± 8.16
	Landscape level	Range 4.60 – 31.50; Average 14.12 ± 4.94
Molluscs	Spraint site level	Range 0.00 – 31.50; Average 6.01±5.52
	Landscape level	Range 0.00 – 11.6; Average 5.85 ± 2.55
Insects	Spraint site level	Range 0.00 – 17.60; Average 2.71 ± 2.80
	Landscape level	Range 0.00 – 7.00; Average 2.55 ± 1.33
Frogs	Spraint site level	Range 0.00 – 14.00; Average 1.21 ± 2.12
	Landscape level	Range 0 – 4.10; Average 1.22 ± 1.03

Table 2. Predictor variables used in the GLM models

Environmental Variables	**Model Type**	**Data Summary (min, max, average±SD, or number of data)**
Cultivation Stage	Point	Preparation = 44 Vegetative = 234 Generative = 91 Postharvest = 32
	Landscape level	Preparation = 12 Vegetative = 20 Generative = 14 Postharvest = 9
Rainfall	Point	Range 169 – 643 mm Average 369.53 ± 168.36
	Landscape level	Range 169 – 643 mm Average 373.78 ± 172.9
Temperature	Point	Range 24.7 – 31.2 Average 26.19 ± 1.67
	Landscape level	Range 24.7 – 31.2 Average 26.12 ± 1.58
Water Level	Point	Range 0 – 17 cm Average 2.25 ± 2.97
	Landscape level	Range 0.31 – 4.16 cm Average 1.64 ± 0.75

We explored all combination between predictor variable and then analyzed using the General Linear Model (GLM). The best model is selected based on the value of Akaike's Information Criterion (AIC). The best modeling is chosen based on the smallest AIC value. When there are two or more models that have the smallest AIC value (ΔAIC <2), the model that has the least number of parameters is chosen.

RESULTS

We found that the diet composition of small-clawed otters in the paddy fields consist of fishes, snails, insects, frogs, crabs, mammals, birds and reptiles. Fish showed as dominant composition in the diet. Remains of fish were almost found in every spraint specimen (99.04% of occurrence frequency). We found snails (dominantly golden-apple snails) in high occurrence frequency (91.08%) in the diet composition, although SBE of the category was not such high (24.84%). Remains of crabs were found in only 4.10% occurrence frequency (Table 3).

Table 3. Diet composition of small-clawed otter in a paddy field landscape (n=415)

Category	OF	ROF	SBE	RII
Fish	99.04%	32.21%	57.13%	63.57%
Snails	91.08%	29.62%	24.84%	25.43%
Insects	71.08%	23.12%	11.22%	8.96%
Frogs	34.46%	11.21%	5.06%	1.96%
Mammals	4.82%	1.57%	0.76%	0.04%
Crabs	4.10%	1.33%	0.64%	0.03%
Aves	2.41%	0.78%	0.29%	0.01%
Reptile	0.48%	0.16%	0.06%	0.0003%

OF= Occurrence Frequency, ROF = Relative Occurrence Frequency, SBE= Score-Bulk Estimate, RII = Rescaled Important Index).

GLM analyses revealed that temperature, rainfall, water level and cultivation stage were not significantly related to fish composition in small-clawed otter diet (Table 4). The best model for fishes in both spraint-site and landscape level was the model without predictor variable (null model) (Table 5). Water level showed positive relationship to snails in the diet composition in spraint site level (AIC = 2508.53, P=0.0449) (Fig. 2). However, there was no predictor has significant relationship in landscape level. Temperature showed positive relationship to insect and frogs in the diet composition in both spraint site and landscape level (all P<0.01) (Fig. 3; Fig. 4).

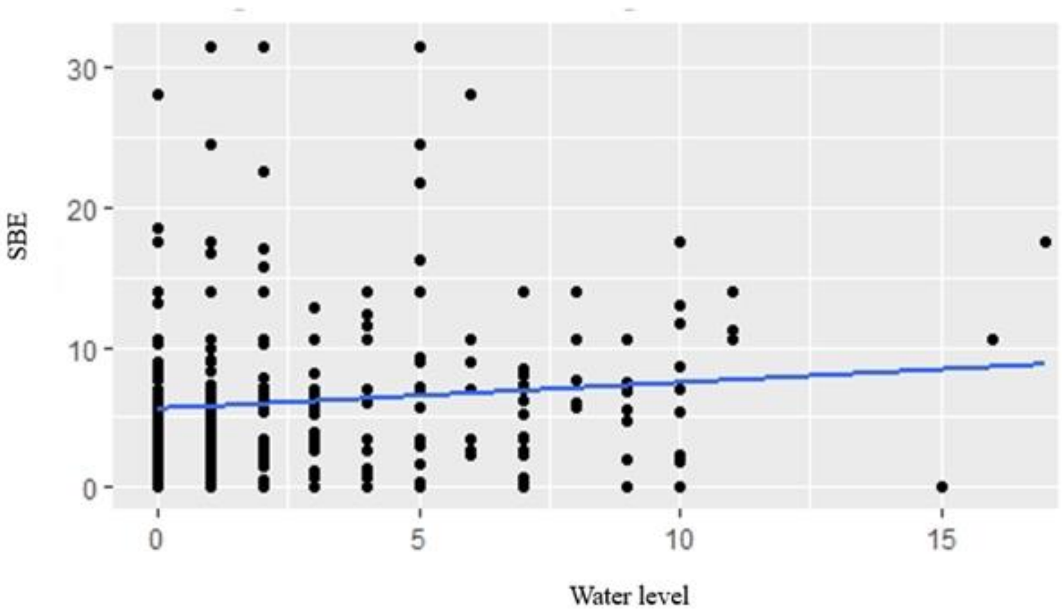


Figure 2. Relationship between paddy field water level and snails in diet composition of small-clawed otters in spraint site level

Table 4. Estimation of the best modeling parameters in diet composition of small-clawed otter. Only models that have ΔAIC < 2 are listed in this Table (N=401)

Prey Item	Model Type	Model Covariate	Estimate	SE	Z Value	*P* Value	AIC	ΔAIC
Fishes	Spraint site level	null					2823.01	0
	Landscape level	null					334.78	0
Snail	Spraint site level	temperature + water					2508.47	0
		water					2508.53	0,06
		intercept	5.59115	0.34422	16.243	<0.00001***		
		water	0.18586	0.09238	2.012	0.0449*		
		stage + temperature + water					2509.75	1.28
		stage + water					2509.83	1.36
		rainfall + water					2510.06	1.59
	Landscape level	rainfall					261.7	0
		null					261.96	0.04
		intercept	5.8473	0.3436	17.02	<0.00001***		
		rainfall + water					263.05	1.35
		water					263.3	1.6
		rainfall + temperature					263.64	1.94
Insect	Spraint site level	temperature					1960.61	0
		intercept	-3.15377	2.17753	-1.448	0.14831		
		temperature	0.22405	0.08299	2.700	0.00723**		
		rainfall + temperature					1962.58	1.97
		temperature + water					1962.60	1.99
	Landscape level	stage + rainfall + water + temperature					184.06	0
		stage + water + temperature					184.79	0.73
		temperature					185.61	1.55
		intercept	-5.1303	2.8443	-1.804	0.07696.		

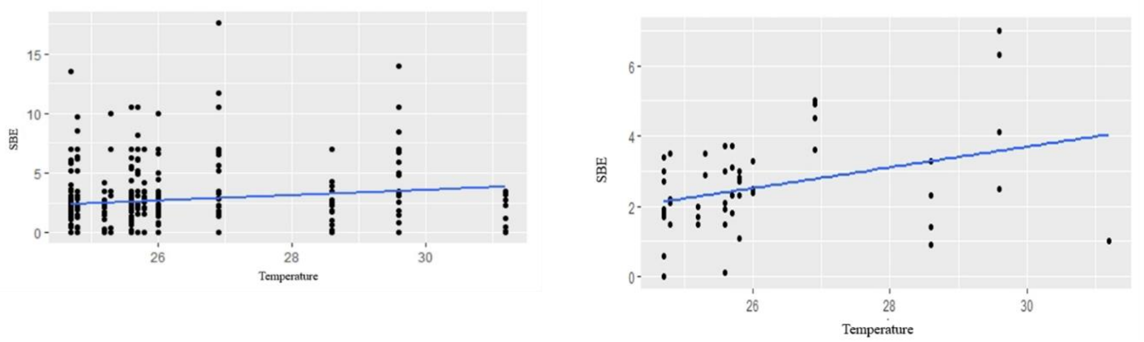
		temperature	0.2940	0.1087	2.705	0.00916**		
Frogs	Spraint site level	temperature					1735.48	0
		intercept	-4.43998	1.64457	-2.700	0.7234**		
		temperature	0.21574	0.06267	3.442	0.000638***		
	Landscape level	temperature					156.01	0
		intercept	-5.20898	2.17311	-2.397	0.02009*		
		temperature	0.24610	0.083404	2.964	0.00455**		
		rainfall + temperature					157.03	1.11
		water + temperature					157.97	1.35

Table 5. Summary of significant predictor variables for the best models

Prey Category	Spraint site level	Landscape level
Fishes	null	null
Snails	water	null
Insects	temperature	temperature
Frogs	temperature	temperature

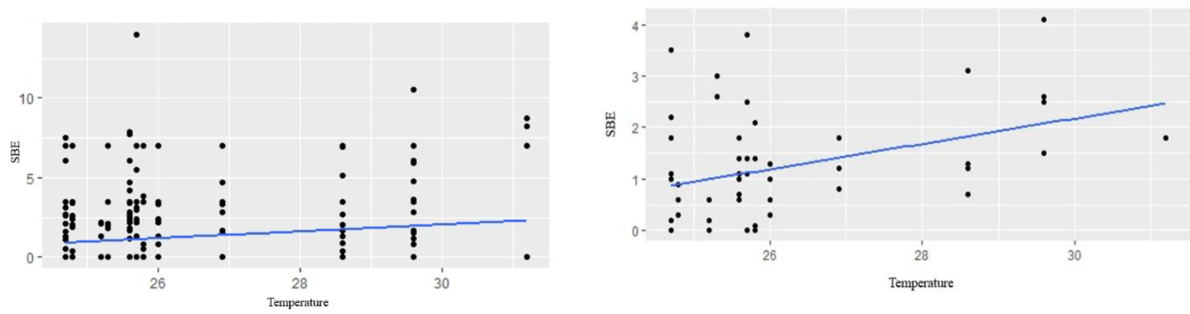
Table 6. Comparison of diet composition of small-clawed otters from this study with published data (OF = Occurrence frequency. ROF = relative occurrence frequency)

No	Category	This study		Kruuk et al., (1994)		Hon et al., (2010)	Kanchasanaka and Duplaix, (2011)	Abdul Patah et al., (2014)
		%OF	%ROF	%OF	%ROF	%weight	%BP	%OF
1	Crab	4.10	1.33	95	90	85	40.50	22.2
2	Snail	91.08	29.62	-	0	-	22.10	8.3
3	Insect	71.08	23.12	5	0	-	3.10	41.7
4	Fish	99.04	32.21	40	5	10	19.30	27.7
5	Amphibian	34.46	11.21	40	5	-	0.10	-
7	Aves	2.41	0.78	-	-	-	-	-
8	Reptile	0.48	0.16	-	-	-	8.50	-
9	Mammals	4.82	1.57	15	0	-	-	-
10	Shrimp	-	-	-	-	-	0.30	-
11	Not identified	-	-	-	-	5	6.10	-



(a) spraint site level (b) landscape level

Figure 3. Relationship between temperature and insects in diet composition of small-clawed otters



(a) spraint site level (b) landscape level

Figure 4. Relationship between temperature and frogs in diet composition of small-clawed otters

DISCUSSION

Diet Composition

This study found that fish are the dominant diet of small-clawed otter. This result differs from studies in other natural habitats, such as in Thai rivers (Kruuk et al., 1994), in the northeastern rivers of Cambodia (Hon et al., 2010), in peat swamp forests of southern Thailand (Kanchanasaka and Duplaix, 2011) that showed crabs as a dominant food, and in combined habitat type in peninsular Malaysia that showed insects as a dominant food (Abdul-Patah et al., 2014) (Table 6). Habitat changes may cause the transition of dominant prey. Because otters are opportunistic predators, they will forage on prey species according to the prey available in their habitat (Clavero et al., 2003).

The availability of prey is the main factor that determines the diet of otters in their habitat (De Silva, 1991; Foster-Turley, 1992; Kruuk, 2006). Crab is lacking in our study site. As a comparison, paddy fields in Java that were described by Melisch et al. (1996) were destroyed by Potamon crabs. Paddy fields with irrigation canals allow fishes to be available as prey to small-clawed otters. The existence of paddy fields that are close to community settlements that have fish ponds, can be also a factor that causes fish to become the dominant food, although it is necessary to examine whether the small-clawed otters in this location prey on fish from community ponds or from small watercourses in the paddy fields.

The snail category also appeared as dominant in the diet composition of small clawed otters (91.08% occurrence frequency). Golden apple snail (*Pomacea canaliculata*) is abundant in this paddy field. We could not confirm yet whether the snails are food substitution for crabs or not; however, the morphology of the last two, large, upper teeth of small-clawed otters are specialized to crush crabs and other hard-shelled prey (Hussain et al., 2011). The Golden apple snail is an invasive species that has developed into a pest of rice plants in rice fields throughout the world (Suharto, 2002). Golden apple snails are therefore classified as the 100 worst invasive species in the world by the Invasive Species Group (ISSG) (Lowe et al., 2000). This result may be used to design the future development of environmentally friendly agriculture. Without using chemicals, farmers may control the golden apple snail pest by using the small-clawed otters as natural pest controls. Further research is necessary to confirm the effectiveness of this.

The Relationship of Environmental Factors with the Diet of Small-Clawed Otters.

Interestingly, there was no predictor for a relationship with fishes in the diet composition of small-clawed otter. This finding suggests that, availability of fishes in the paddy field did not relate to the dtage of cultivation. Cultivation in our study site is asynchronous. Even though one paddy field has entered a post-harvesting stage, the other paddy fields may still in vegetative stage. In such conditions, the canals and ditches are mostly inundated by water throughout the year. The main source of fishes is probably the irrigation ditches and canals. Moreover, in tropical climate regions, the growth and reproduction cycles of fishe are mostly asynchronous. The availability of fish will be biologically stable throughout the year.

Snails in the diet of small-clawed otters had a positive correlation with water level. The slow moving traits of snails limit them to be highly depend on the conditions in a particular paddy field. According to a0 previous study (Aadrean and Usio, 2020), the availability of snails was greatest when the water level was higher. Furthermore, Widjajanti (1989) revealed that the snail population tends to decrease in the last third of the period of rice growth and before the harvest, because at that time the paddy water is reduced or almost dry.

The composition of insects in the diet is positively related to temperature. This is in accordance with the statement of Haneda et al., (2013) that an increase in temperature will affect the activity of insects, distribution, and breeding. Higher temperature will increase availability of insects in the paddy field. Similarly, the amountof frogs in otter diets is also positively related to temperature. The presence of animals that are exothermic, such as insects and amphibians, is closely correlated to environmental temperature. In the study of Browne and Edward (2003), temperature influences the growth and development of an amphibian species. Amphibians are an important part of the otter diet in many locations (Erlinge, 1972; Brzeziñski et al., 1993; Sulkava, 1996). Most of the research conducted to look at the annual pattern of the highest amphibian consumed by otters occurs in late winter and early spring (Weber, 1990; Brzeziñski et al., 1993; Sulkava, 1996).

Our study results may be used to enhance paddy cultivation management. If we consider an environmentally friendly agriculture system, water management and asynchronous cultivation system should be included in the consideration.

ACKNOWLEDGEMENTS - We would like to thank Mahfud Huda, Evan Ananta, Team Verteb Andalas University and all members of Museum Zoology Andalas University. This study was funded by Andalas University (contract number T/49/UN.16.17/PT.01.03-IS-RD/2020). The spraint collection project was funded by Rufford Small Grants (No.17544-2).

REFERENCES

Aadrean, Usio, N. (2017). Small-clawed otters (*Aonyx cinereus*) in Indonesian rice fields: latrine site characteristics and visitation frequency. *Ecological Research*, **32:** 899-908

Aadrean, Usio, N. (2020). Spatiotemporal patterns of latrine-site use by small-clawed otters in a heterogeneous rice field landscape. *Mammal Study* **45:** 103–110

Aadrean, Novarino, W., Jabang. (2011). A record of small-clawed otters (*Aonyx cinereus*) foraging on an invasive pest species, golden apple snails (Pomacea canaliculata) in a West Sumatra rice field. *IUCN Otter Specialist Group Bulletin*, **28**: 34-38.

Aadrean, Salmah, S., Salsabila, A., Rizaldi., Janra, M. N. (2010). Tracks and other signs of otters in rice fields in Padang Pariaman, West Sumatra: a preliminary study. *IUCN Otter Specialist Group Bulletin*, **27**: 6-11.

Abdul-Patah, P., Nur-Syuhada, N., Md-Nor, S., Sasaki, H., Md-Zain, B.M. (2014). Habitat and food resources of otters (mustelidae) in peninsular malaysia. *AIP Conference Proceedings* **1614**: 693–699. DOI: https://aip.scitation.org/doi/abs/10.1063/1.4895286

Anoop, K.R., Hussain, S. A. (2005). Food and feeding habits of smooth-coated otters (*Lutra perspicillata*) and their significance to the fish population of Kerala, India. *Journal of Zoology*, **266**:15-23.

Browne, R.K., Edwards, D.L., (2003). The effect of temperature on the growth and development of the endangered green and golden bell frog (*Litoria aurea*). *J. Therm. Biol*. **28**: 295–299.

Brzeziñski, M., Jedrzejewski W. and Jedrzejewska B. (1993). Diet of otters (*Lutra lutra*) inhabiting small rivers in the Bialowieza National Park, eastern Poland. *Journal of Zoology*, **230**: 495-501.

Che Salmah, M.R., Siregar, A.Z., Abu Hassan, A., Nasution, Z. (2017). Dynamics of aquatic organisms in a rice field ecosystem: effects of seasons and cultivation phases on abundance and predator-prey interactions. *Tropical Ecology* **58**: 177-191

Clavero, M., Prenda, J., Delibes, M. (2003). Trophic diversity of the otter (*Lutra lutra*). in temperate and Mediterranean freshwater habitats. *Journal of Biogeography*. **30**: 761-769.

De Silva, P.K. (1991). Distribution of *Lutra lutra* in the Highlands of Sri Lanka *IUCN Otter Spec. Group Bull*. **6**: 2-5

Erlinge, S. (1972). Interspecific relations between otter (*Lutra lutra*) and mink (Mustela vison) in Sweden. *Oikos*, **23**: 327-335

Fonseca, V.C., Rheingantz, M.L., Fernandez, F.A. (2008). A comparison of two different methods for estimating the diet of the neotropical otter, *Lontra longicaudis*, with the proposal of a new index for dietary studies. *IUCN Otter Spec. Group Bull.* **25**: 6-12

Foster-Turley, P. (1992). Conservation aspects of the ecology of Asian small-clawed and smooth otters on Malay peninsula. *IUCN Otter Spec. Group Bull.* 7: 26 -29

Haneda, N.F., Kusmana, C., Kusuma, F.D. (2013). Insect diversity in mangrove ecosystems. *Jurnal Silvikultur Tropika*. **4**: 42-46.

Heong, K.L., Aquino, G.B., Barrion, A.T. (1991). Arthropod community structures of rice ecosystems in the Philippines. *Bulletin of Entomological Research*, **81**: 407-416.

Hon, N., Neak, P., Khov, V., Cheat, V. (2010). Food and habitat of Asian small-clawed otter in northeastern Cambodia. *IUCN Otter Spec Group Bull* **27**(1): 12-23.

Hussain, S.A., Gupta, S.K., De Silva P.K. (2011). Biology and ecology of Asian small-clawed otter *Aonyx cinereus* (Illiger, 1815): a review. *IUCN Otter Spec Group Bull* **28**: 63–75.

Kanchasanaka, B., Duplaix, N. (2011). Food Habits of the Hairy-nosed otter (*Lutra sumatrana*) and the Small-clawed otter (*Aonyx cinereus*) in Pru Toa Daeng Peat Swamp Forest, Southern Thailand. *IUCN Otter Spec. Group Bull.* **28**(A): 139-149.

Kruuk, H. (2006). Otters: Ecology, Behaviour and Conservation. Oxford University Press. ISBN-13: 9780198565871. DOI:10.1093/acprof:oso/9780198565871.001.0001

Kruuk, H., Kanchanasaka, B., O'Sullivan, S., Wanghongsa, S. (1994). Niche separation in three sympatric otters *Lutra perspicillata, L. lutra* and *Aonyx cinereus* in Huai Kha Khaeng, Thailand. *Biol. Conserv.* **69**: 115-120.

Lowe, S., Browne, M., Boudjelas, S., De Poorter, M. (2000). 100 of the World's Worst Invasive Alien Species A selection from the Global Invasive Species Database. IUCN Invasive Species Specialist Group (ISSG).

Melisch, R., Asmoro, P.B., dan Kusumawardhami, L. (1994). Major Steps Taken Towards Otter Conservation in Indonesia. *IUCN Otter Spec. Group Bull*. **10**: 21-24.

Melisch, R., Kusumawardhani, L., Asmoro, P.B., Lubis, I.R., (1996). The Otters of West Java: A Survey of Their Distribution and Habitat Use and a Strategy Towards a Species Conservation Programme. PHPA/Wetlands International - Indonesia Programme, Bogor.

Okamoto, Y., Maeda, N., Hirabayashi, M., Ichinohe, N., (2020). The Situation of Pet Otters in Japan – Warning by Vets. *IUCN Otter Spec. Group Bull*. **37** (1):71 – 79

Remonti, L., Balestrieri, A., Prigioni, C. (2009). Altitudinal gradient of Eurasian otter (*Lutra lutra*) food niche in Mediterranean habitats. *Canadian Journal of Zoology*, **87**(4): 285–291.

Sivasothi, N., Nor, B.H.M. (1994). A review of otters (Carnivora: Mustelidae: Lutrinae) in Malaysia and Singapore. *Hydrobiologia* **285**: 151-170.

Suharto, H. (2002). Golden Apple Snail, *Pomacea canaliculata* (Lamarck) in Indonesia. In: **Wada, T., Yusa, Y., Joshi, R.C., Ghesquiere, S.** (eds.). Proceedings of the special working group on the golden apple snail (*Pomacea* spp.). The Seventh International Congress on Medical and Applied Malacology (7th ICMAM).

Sulkava, R. (1996). Diet of otters *Lutra lutra* in central Finland. *Acta Theriologica*, **41**: 395-408.

Wang, J., Gao, W., Wang, L., Metzner, W., Ma, J., Feng, J., (2010). Seasonal variation in prey abundance influences habitat use by greater horseshoe bats (*Rhinolophus ferrumequinum*) in a temperate deciduous forest. *Can. J. Zool*. **88**: 315-323.

Weber, J. (1990). Seasonal exploitation of amphibians by otters (*Lutra lutra*) in north-east Scotland. *Journal of Zoology*, **220**: 641-651.

Widjajanti, S. (1989). Studies on the Biology of *Lymnaea rubiginosa*. MSc Thesis. James Cook University of North Queensland, Townsville, Queensland, Australia.

Wright, L., de Silva, P., Chan, B., Reza Lubis, I. (2015). *Aonyx cinereus*. *The IUCN Red List of Threatened Species* 2015: eT44166A21939068. https://dx.doi.org/10.2305/IUCN.UK.20152.RLTS.T44166A21939068.en.

RÉSUMÉ

RELATION ENTRE FACTEURS ENVIRONNEMENTAUX TEMPORELS ET COMPOSITION DU RÉGIME ALIMENTAIRE DE LA LOUTRE CENDRÉE *(Aonyx cinereus***)** DANS UN PAYSAGE DE RIZIÈRES HÉTÉROGÈNE À SUMATRA, EN INDONÉSIE

La loutre cendrée (*Aonyx cinereus*) est l'une des quatre espèces de loutres en Indonésie. Cette espèce consomme différents espèces d'animaux. La disponibilité en proie dépend de ses conditions environnementales. En conséquence, cette étude visait à examiner la relation entre les facteurs environnementaux temporels et la composition du régime alimentaire de la loutre cendrée dans un paysage des rizières. Nous avons examiné 415 épreintes collectées dans ce paysage hétérogène de rizières à l'ouest de Sumatra, en Indonésie. Nous avons constaté que la loutre cendrée consommait des poissons, des escargots, des crabes, des reptiles, des grenouilles, des oiseaux et des mammifères. Contrairement au milieu naturel, le poisson est devenu le régime alimentaire dominant plutôt que les crabes. De plus, nous avons effectué une analyse à l'aide du Modèle Linéaire Généralisé (MLG) pour expliquer les facteurs environnementaux temporels qui affectent la composition du régime alimentaire de la loutre cendrée. Les analyses du MLG ont révélé que la température, les précipitations, le niveau de l'eau et le stade de la culture n'étaient pas significativement corrélés à la composition des poissons du régime alimentaire de la loutre cendrée. Il y avait une corrélation positive entre le niveau de l'eau et la présence d'escargots dans la composition du régime alimentaire. De même, il existait une corrélation positive entre la température et la présence d'insectes et de grenouilles dans la composition du régime alimentaire.

RESUMEN

RELACIÓN ENTRE FACTORES AMBIENTALES TEMPORARIOS Y COMPOSICIÓN DE LA DIETA EN LA NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA (*Aonyx cinereus*) EN EL PAISAJE HETEROGÉNEO DE ARROZALES EN SUMATRA, INDONESIA

La nutria de uñas pequeñas asiática (*Aonyx cinereus*) es una de las cuatro especies de nutria que hay en Indonesia. Esta especie consume varios tipos de animales. La disponibilidad de presas depende de las condiciones ambientales. Por lo tanto, este estudio estuvo dirigido a examinar la relación entre factores ambientales temporarios y la composición de la dieta de la nutria de uñas pequeñas, en un paisaje de arrozales. Examinammos 415 fecas colectadas en un paisaje heterogéneo de arrozales en Sumatra Occidental, Indonesia. Encontramos que la nutria de uñas pequeñas consume peces, caracoles, cangrejos, reptiles, ranas, aves, y mamíferos. A diferencia de los hábitats naturales, los peces fueron dominantes en la dieta, en lugar de los cangrejos. Además, llevamos a cabo un análisis de Modelo Lineal Generalizado (GLM) para explicar los factores ambientales temporarios que afectan la composición de la dieta de la nutria de uñas pequeñas. Los análisis GLM revelaron que la temperatura, precipitación, nivel del agua y estadío de cultivo no estuvieron relacionados significativamente con el peso de los peces en la dieta de las nutrias. El nivel del agua mostró una relación positiva con el peso de los caracoles en la composición de la dieta. La temperatura mostró una relación positiva con el peso de los insectos, y de las ranas, en la composición de la dieta. showed positive relationship to both insect and frogs in the diet composition.

OSG MEMBER NEWS

Membership Review

We have completed the review of membership necessary at the beginning of each new Quadrennium of the IUCN/SSC. The Otter Specialist Group contains 324 members at 7th April 2021.

New Members of OSG

Since the last issue, we have welcomed 5 new and 1 returning new members to the OSG: you can read more about them on the Members-Only pages.

Rosanne Adey, UK: For my degree, I studied prey in otters on the Isle of Mull. Since then, I have studied otter interaction and tourism effects on local otters on Benbecula, where I now live, and where I am currently building an otter rehabilitation centre, which will also facilitate survey training, and teach rehabilitation techniques.

Sarah du Plessis, UK: I am a PhD student with the Cardiff University Otter Project, undertaking a research project using genomics to study the history of the Eurasian otter specifically in the UK. I am a part of the team at Cardiff University conducting weekly post-mortems of road killed otters, maintaining a long term dataset across the UK from 1994 to present day. We collect measurements, observations, and samples of a range of tissues.

Georgina Kelly, UK: I am a senior ecologist, working as the aquatic species lead, overseeing mitigation surveys for otter, water vole and riparian habitats on HS2 Phase 1, a large railway project in the south of England. I am a member of the River Restoration Centre and in the process of gaining accreditation with the RRC to carry out River Habitat Surveys (RHS). I was both an ecologist and wildlife guide for five years based on the Isle of Mull in the Western Isle. s.My main interest is otter behaviour, as further understanding of this enhances the quality of surveys. Much of our knowledge of Eurasian otter behaviour has been gleaned from studies into coastal populations which impacts the interpretation of river based data, and in turn, poses a major limitation on the mitigation strategies imposed on developments.

Danielle Lima, Brazil: I have worked on neotropical and giant otters since 2001, and now monitor areas impacted by large projects in the Amazon. Since 2006, I have lived in Amapá State, where we carry out distributional inventory in the region, in addition to documenting conflicts.

Barbara Macfarlane, UK: I am an ecologist proficient in survey techniques and long term camera trapping as well as developing mitigation plans to protect otters during unavoidable developments. I am also a marine mammal medic with British Divers Marine Life Rescue and through the course of this work, am liaising with the Scottish SPCA to identify suitable release sites for rehabilitated otters.

Emily O'Rourke, UK: I am currently completing my PhD with Cardiff University Otter Project, focussing on chemical contaminants in otters, looking at a range of contaminants from the largely banned legacy compounds to the more emerging groups (e.g., PCBs, organochlorine pesticides, PBDEs, PFAS and pharmaceuticals). I also take an active role in the running of the Otter Project, organising and undertaking the post mortems on the otters we receive from across Britain. For the last three months I have been working as the Project Officer on a grant funded by the Wales Trunk Roads Agency with the aim of developing a more coordinated approach to recording and preventing otter road mortalities across Wales.