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!

It is autumn here at my place and outside my house the vine leaves turn yellow. Now we open the issue 40/4 in 2023 which will be the last one for this year. There is quite some variety of topics and species in the pipeline.

We observe a steady increase of submitted manuscripts covering also more topics than in the past. Therefore, we foresee some changes in the review process to increase reliability of data and further improve the quality of manuscripts which is in the interest of us as scientists but also in the interest of the journal. Finally, this also serves the species we are interested in.

Lesley is of invaluable help, and I do not know how to do it without her. Originally starting from being the technical webmaster, she is now also doing all the work in respect to language editing and the final quality control in the form of checking references etc. There are always some small or big things that slip through reviews and proofprints.

Lesley, thank you so much for all your time, efforts, and knowledge you invest in order to make this journal an increasing success.

OBITUARY

REMEMBERING ALEŠ TOMAN

On September 8th of this year, RNDr. Aleš Toman (1956) left us prematurely. His last trip to his beloved Africa was fatal.

Aleš studied Systematic Biology and Ecology at the Faculty of Science in Olomouc, but he lived most of his life in the Czech Highlands. He started his professional career at the Museum of Highlands in Jihlava, where he worked as a zoologist. An important period of his life was his work at the Otter and Fauna Protection Station in Pavlov near Ledeč nad Sázavou, which was established from the beginning of the 1990s as part of the then Czech Institute of Nature Conservation - later the AOPK ČR. After many years as head of the station, he moved to the Jihlava Zoo and then to the Plzeň Zoo, and then as the head of the municipal shelter for abandoned animals in Jihlava. Since 1992, his great love was Africa, where he travelled several times a year as a guide on natural history expeditions.

Photo 1. Aleš devoted a significant part of his life to otters (2003, archive of Pavlov Otter and Fauna Protection Station)

Our professional cooperation started in the early 1990s. The youthful enthusiasm combined with the freedom provided by the velvet revolution in CZ 1989 was an ideal starting point. At that time a nice cooperation started with the Dutch Otterstation Foundation. We embarked on the rescue of the then critically endangered otter together with full commitment. Pavlov soon became not only an Otterstation on a national level. We became active members of the IUCN Otter Specialist Group, and we established intensive cooperation with otter conservation organisations in Europe and around the world. In 1993, a Dutch sponsor enabled us to participate in the VIth International Otter Colloquium in South Africa, and many other joint trips followed (Scotland, Netherlands, Zimbabwe, the Danube Delta and many others).

The many weeks spent in our countryside, in Třeboň region during otter trapping for telemetry research, nights during telemetry in the Jeseníky Mountains, will never fade from our memory. Our common otter work was gradually extended to other species - the peregrine and saker falcon, the European mink in the Danube Delta, black Grouse, woodpeckers and migratory bird species in the Austrian Alps and the endangered owls, which gradually brought other joint activities.

Photo 2. There were countless experiences together - here together with Vašek Beran and Vašek Hlaváč, a narcotized moose was carried across the highway (2001, archive of AOPK ČR).

It remained so even after Aleš's departure to the Jihlava Zoo and actually until the last days. On the seventh of September 2023, our film about beaver wetlands was premiered at the Jihlava Zoo, for which Aleš provided beautiful footage of kingfishers. He was supposed to be at the premiere. But Ales didn't come. Early the next morning it became clear that he was losing his battle with malaria at the time of the premiere.

Aleš had his share of difficult moments in life, but he always managed to overcome them with his eternal smile and optimism and his ability to enjoy life to the fullest. His undying vigour influenced a wide range of people interested in nature until his last days, whether at home or during his many travels in Africa. He was also a great embassador of Czech humor and culture. He will be greatly missed by all who knew him.

Václav Hlaváč, Addy de Jongh and Andreas Kranz

Photo 3. Aleš in Africa (unknown photographer)

O B S E R V A T I O N

FIRST PHOTOGRAPHIC RECORDS OF SMOOTH-COATED OTTER (*Lutrogale perspicillata*) IN JHARSUGUDA FOREST DIVISION, ODISHA, INDIA

Nimain Charan PALEI[1], Bhakta Padarbinda RATH[1], Lalit Kumar PATRA[2], Biswajit GHOSH[3]

[1]*Office of the Principal Chief Conservator of Forests (Wildlife) & Chief Wildlife Warden, Odisha, India*
[2]*Divisional Forest Officer, Jharsuguda Forest Division, Jharsuguda, Odisha, India*
[3]*Office of the Divisional Forest Officer, Jharsuguda Forest Division, Jharsuguda, Odisha, India*
Corresponding author: wildpalei@gmail.com




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Abstract: The smooth-coated otter is an IUCN-Vulnerable species as a result of habitat loss and poaching. We deployed 15 camera traps, in two phases, in Jharsuguda Forest Division, on 8th June and 5th August 2022, with a total sampling effort of 750 trap days. Out of 1682 camera trap photographs, one photograph capture of smooth-coated otter was recorded, where there had previously been no smooth-coated otter records. This study presents a novel record of Smooth-coated otter *Lutrogale perspicillata* in Jharsuguda Forest Division, Odisha, India.
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Keywords: Smooth-coated otter, camera trapping, Jharsuguda Forest Division, Odisha, India

INTRODUCTION

The smooth-coated otter (*Lutrogale perspicillata*, Geoffroy), a medium sized otter weighing between 7 and 11 kg (Prater, 2005) is distributed throughout southern Asia from Indonesia, through southeast Asia, and westwards through southern China, Pakistan and India, with an isolated population in Iraq (Pocock, 1941; Hussain, 1993; de Silva et al., 2015). In India, it is continuously distributed from the foothills of Himalayas southward to southern India occurring in major rivers and coastal areas (Prater, 2005; Hussain, 1993). Smooth-coated otter is a semi-aquatic social carnivore depending on wetland habitats and vulnerable to loss and degradation of habitat, since wetlands are currently among the most threatened and vanishing ecosystems worldwide (Davidson, 2014). Poaching for pelts, and retaliatory killing as a result of otter-human conflicts, are also threatening the survival of this species across its distribution range (de Silva et al., 2015). Therefore, it has been categorized as 'Vulnerable' in the IUCN Red List of Threatened Species (de Silva et al., 2015) and legally protected under Schedule-I of the Indian Wildlife (Protection) Act, 1972.

Out of thirteen extant species of otters found worldwide, India is home to three species, namely the Asian Small-Clawed Otter (*Aonyx cinereus*), the Smooth-Coated Otter (*Lutrogale perspicillata*) and the Eurasian Otter, *Lutra lutra* (Hussain, 1999). In India, the Asian Small-Clawed Otter is found from the Himalayan foothills of Himachal Pradesh to West Bengal, Northeast India, as well as in southern Indian hill ranges of Karnataka, Tamil Nadu and Kerala (Pocock, 1941; Hussain et al., 2011) and eastern India of Odisha (Mohapatra et al., 2014). The Smooth-Coated Otter is distributed throughout India from the Himalayas southwards, and has been reported from the north Indian states of Himachal Pradesh, Punjab, plains of Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar, in the central Indian plateau of Madhya Pradesh, Maharashtra, Goa, Andhra Pradesh, in the east and northeast in Odisha, West Bengal, Assam through Burma, in the south in Karnataka, Kerala, and Tamil Nadu (Prater, 1971; Hussain, 1999).

In Odisha, all three species of otters have previously been reported (Acharjyo, 1999; Mohapatra et al., 2014; Palei et al., 2021; Palei et al., 2022). The Smooth-Coated Otter's distribution covers most parts of the Odisha, like Bhitarkanika Wildlife Sanctuary and Chilika Wildlife Sanctuary (Palei et al., 2020; Adhya and Dey, 2020). Here we provide the first record of the Smooth-Coated Otter in Jharsuguda Forest Division, western Odisha.

STUDY AREA

The Jharsuguda Forest Division is situated at Latitude 21.57ºN to 22.01ºN and longitude 83.42ºE to 84.38ºE. The Division is the northwestern part of the state of Odisha. The forest reserve is located in the southern part of the Jharsuguda Forest Division (Fig. 1) with an area of 392.71 ha (Sunari Dungri Reserve Forest). The mean daily temperature of winter ranges from 10 °C to 13 °C and that of summer from 30 °C to 47 °C. There are three distinct seasons: Summer - March to June, Rainy - July to October, and winter - November to February.

The rainfall of the Sanctuary and the nearby areas varies from 1000 mm to 1700mm. Due to good rainfall in the Division area, moist peninsular high-level Sal and moist mixed deciduous forests are found. Most local people in the RF are villagers, and their activities inside the forest are grazing livestock, and collection of forest products (e.g. fodder for livestock, non-timber). The Division is dominated by Northern Tropical Dry Deciduous Forest, Dry Peninsular Sal Forests and Northern Dry Mixed Deciduous Forests. (Champion and Seth, 1968). The Reserve Forest contain forest of good quality, with *Terminalia tomentosa. Anogeissus latifolia. Pterocarpus marsupium, Diospyros melanoxylon, Adina cordifolia, Terminalia chebula, terminalia bellerica, lagerstroemia parviflora, Buchananialanzyn, Lanniacoromandelica and Dalbergia latifolia* etc. The common plants are *Emblica officinalis, Cassia fistula, Morinda* *tinctoria. Antidesma species,* and *Randia species.* The undergrowth in these forests is a mixture of *Flemingiachappar*, *Indigofera pulchela*, *Wordfordia fruticosa*, *Desmodium* species, and *Strobilanthes* species. The common climbers are *Bauhinia vahlii* and *Smilax* species ,while *Combretum decandrum* occurs in valleys and ravines.

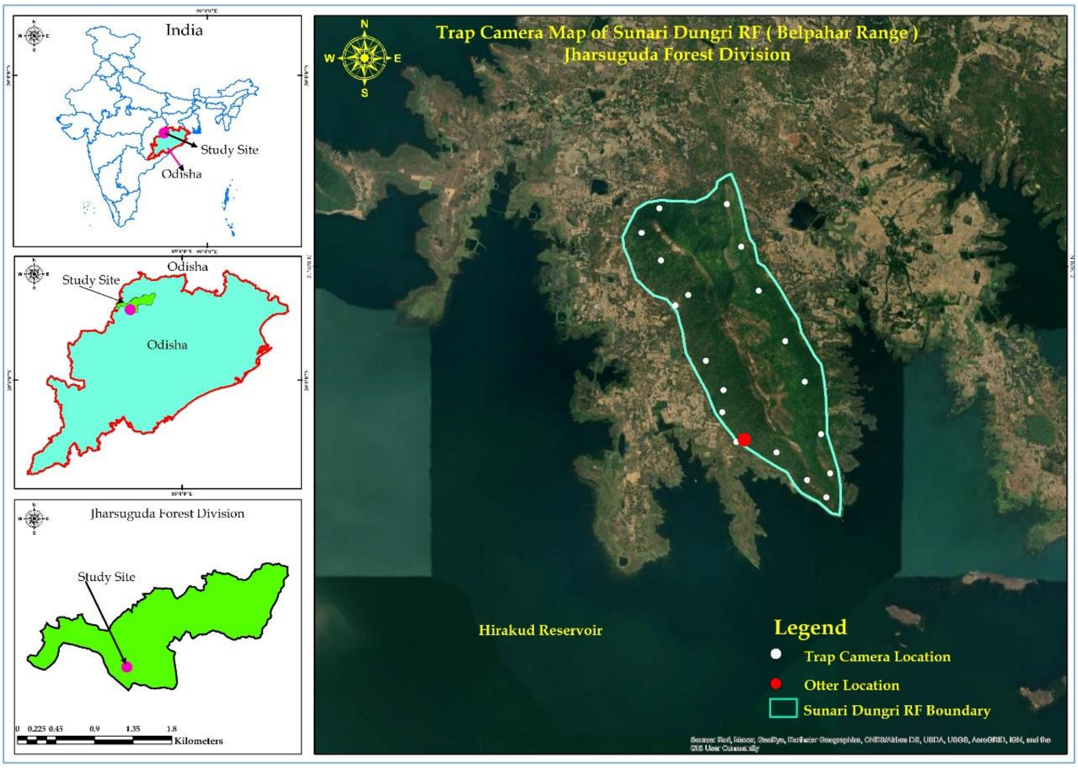

Figure 1. Study area showing locations of camera traps in the Jharsuguda Forest Division, Jharsuguda.

METHODOLOGY

Camera trap surveys were carried out from 10th June 2022 to 7th July 2022. In Sunadungri reserve forest, fifteen camera trap stations were established in the study area. We selected the most suitable camera trap locations, along animal trails, forest roads and near creeks, based on preliminary sign surveys. At each camera trap station, a pair of automated motion-triggered digital camera-traps (Cuddeback Model C1; Non Typical, Inc., Green Bay, WI) were placed on either sides of the location, strapped to trees, facing each other, around 45-50 cm above the ground, using no lure or bait. All cameras were operational 24 hours per day, and programmed to delay sequential photographs by 30 s recording time. Cameras were checked every week to replace the batteries and memory cards and to ensure their proper functioning. Total sampling effort was calculated as the sum of the effective days across all stations where both cameras were functioning (Boitani and Powell, 2012). Each photograph was manually checked to identify the species. Date, time, and temperature were noted for each identified species. We considered photos separated by at least 30 minutes as independent events (Ohashi et al., 2013; Guo et al. 2017).

RESULTS

From 10th June 2022 to 7th July 2022, we had fifteen locations covering an area of 392.71sq km^2 in the Sunaridungri Reserve Forest in Jharsuguda Forest Division (Fig. 2), a total effort of 450 trap nights, capturing thirteen mammal species, including Smooth-Coated Otter. The Smooth-Coated Otter was first recorded in a camera trap on

13th August 2022 (Fig. 3) in Sunadungri Reserve Forest. This is the first record of this species in Jharsuguda Forest Division.

Figure 2. Camera traps installed in Sunaridongri Reserve Forest, Jharsuguda Forest Division

Figure 3. Smooth-coated otter documented by camera traps in Sunaridongri Reserve Forest Jharsuguda Forest Division

In addition to Smooth coated otters, the other mammalian species recorded during the camera trap survey were leopard (*Panthera pardus)*, rusty spotted cat (*Prionailurus rubiginosus)*, jungle cat *(Felis chaus)*, striped hyena (*Hyaena hyaena)*, golden jackal (*Canis aureus),* Indian fox (*Vulpes bengalensis)*, sloth bear (*Melursus ursinus*), honey badger (*Mellivera capensis*), barking deer (*Muntiacus muntjak)*, wild pig (*Sus scrofa)*, four-horned antelope (*Tertracerus quadricornis)*, and hanuman langur (*Semnopithecus entellus*).

DISCUSSION

As far as we are aware, this is the first photographic record from a camera trap of the smooth-coated otter (*Lutrogale perspicillata*) in Jharsuguda Forest Division. To our surprise, only one image of a single individual was captured during the whole camera trap survey. The camera trap was installed adjacent to the Hirakud Reservoir. The smooth-coated otter's distribution covers most eastern parts of Odisha, including Bhitarkanika Wildlife Sanctuary and Chilika Wildlife Sanctuary (Palei et al., 2020; Adhya and Dey, 2020). The distribution of smooth coated otters in western Odisha seems very scanty. No further camera trap captures or indirect signs were recorded in western Odisha. Our study should be considered only as preliminary results, however. It represents an important contribution towards increasing our knowledge of the Smooth-coated otter. Further detailed research should, therefore, be focused on the otter in the study area in order to have better understanding of the ecology of the species. This information will help generate a more effective conservation and management of the species.

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RESUME
PREMIERS ENREGISTREMENTS PHOTOGRAPHIQUES DE LA LOUTRE À PELAGE LISSE (*Lutrogale perspicillata*) DANS LA DIVISION FORESTIÈRE DE JHARSUGUDA, A ODISHA, EN INDE

La loutre à pelage lisse est une espèce vulnérable selon l'UICN en raison de la perte d'habitat et du braconnage. Nous avons déployé 15 pièges photographiques en deux phases dans la division forestière de Jharsuguda, les 8 juin et 5 août 2022, avec un effort d'échantillonnage total de 750 jours de piégeage. Sur 1.682 photos de pièges photographiques, nous avons enregistré une capture photographique de loutre à pelage lisse dans la division forestière de Jharsuguda, alors qu'auparavant, il n'y avait aucun enregistrement de loutre à pelage lisse dans cette division. Cette étude présente la première observation de loutre à pelage lisse *Lutrogale perspicillata* dans la division forestière de Jharsuguda, à Odisha, en Inde.

RESUMEN
PRIMEROS REGISTROS FOTOGRÁFICOS DE NUTRIA LISA (*Lutrogale perspicillata*) EN LA DIVISIÓN FORESTAL JHARSUGUDA, ODISHA, INDIA

La nutria lisa es una especie Vulnerable (UICN) como resultado de la pérdida de hábitat y la caza ilegal. Desplegamos 15 cámaras-trampa en dos fases (8 de Junio y 5 de Agosto de 2022) en la División Forestal Jharsuguda, con un esfuerzo muestral de 750 días-trampa. De un total de 1.682 fotografías, fue registrada una captura fotográfica de una nutria lisa en la División Forestal Jharsuguda, pero no había registros previos de nutria lisa en ésta División. Este estudio presenta el primer registro de nutria lisa *Lutrogale perspicillata* en la División Forestal Jharsuguda, Odisha, India.

ସାରାଂଶ
ଝାରସୁଗୁଡ଼ା ବନଖଣ୍ଡରେ ନରମ ଆବରଣ ବିଶିଷ୍ଟ (ସ୍ମୁଥ୍ କୋଟେଡ) ଓଧ (*Lutrogale perspicillata*) ର ସର୍ବକାଳୀନ ପ୍ରଥମ ଫୋଟୋଗ୍ରାଫିକ ରେକର୍ଡ଼, ଓଡିଶା, ଭାରତ।

ବାସସ୍ଥଳୀ କ୍ଷୟ ଏବଂ ଶିକାର କାରଣରୁ ନରମ ଆବରଣ ବିଶିଷ୍ଟ (ସ୍ମୁଥ୍ କୋଟେଡ) ଓଧ ଆଇୟୁସିଏନ୍-ବିପଦପ୍ରବଣ ପ୍ରାଣୀ ଭାବେ ପରିଗଣିତ। ଝାରସୁଗୁଡ଼ା ବନଖଣ୍ଡରେ ଦୁଇଗୋଟି ପର୍ଯ୍ୟାୟରେ ଆମେ ୮ ଜୁନ ଏବଂ ୫ ଅଗଷ୍ଟ ୨୦୨୨ ରିଖରେ ୧୫ ଗୋଟି କ୍ୟାମେରା ଟ୍ରାପ ନିୟୋଜନ କରିଥିଲୁ ଯେଉଁଥିରେ ମୋଟ ୭୫୦ ଟ୍ରାପ ଦିନର ନମୁନା ସଂଗ୍ରହ ପ୍ରୟାସ କରାଯାଇଥିଲା। ମୋଟ ୧୬୮୨ଟି କ୍ୟାମେରା ଟ୍ରାପ ଫୋଟୋ ମଧ୍ୟରୁ ଗୋଟିଏ ଫୋଟୋ ନରମ ଆବରଣ ବିଶିଷ୍ଟ (ସ୍ମୁଥ୍ କୋଟେଡ) ଓଧ ଝାରସୁଗୁଡ଼ା ବନଖଣ୍ଡରୁ ରେକର୍ଡ଼ କରାଯାଇଥିଲା; କିନ୍ତୁ ପୂର୍ବରୁ ଝାରସୁଗୁଡ଼ା ବନଖଣ୍ଡରୁ ନରମ ଆବରଣ ବିଶିଷ୍ଟ (ସ୍ମୁଥ୍ କୋଟେଡ) ଓଧ ଉପସ୍ଥିତିର କୌଣସି ରେକର୍ଡ଼ ଉପଲବ୍ଧ ନଥିଲା। ଏହି ଅଧ୍ୟୟନ ଝାରସୁଗୁଡ଼ା ବନଖଣ୍ଡ, ଓଡିଶା, ଭାରତରେ ନରମ ଆବରଣ ବିଶିଷ୍ଟ (ସ୍ମୁଥ୍ କୋଟେଡ) ଓଧ **(*Lutrogale perspicillata*)** ର ସର୍ବକାଳୀନ ପ୍ରଥମ ରେକର୍ଡ଼ ଉପସ୍ଥାପନ କରୁଅଛି।

REPORT

POPULATION STATUS AND TEMPORAL ACTIVITY PATTERN OF TWO VULNERABLE OTTER SPECIES FROM CAMERA-TRAPPING IN THE SOUTHERN WESTERN GHATS BIODIVERSITY HOTSPOTS

Kannadasan NARASIMMARAJAN[1*], Matthew W. HAYWARD[2], Sonaimuthu PALANIVEL[3], Manu Thomas MATHAI[1]

[1]*Department of Zoology, Madras Christian College, Tambaram, Chennai – 600059, India*
[2]*Conservation Science Research Group, University of Newcastle, Callaghan, NSW 2308, Australia*
[3]*PG Department of Botany, The New College, Royapettah, Chennai – 600 014, India*
**Corresponding authour: Wildlife9protect@gmail.com*

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ABSTRACT: India is moving towards having the highest number of threatened species in th world, yet since the turn of the twenty-first century some flagship species, such as otters, have been poorly studied in their natural habitats. Here, the population and temporal activity patterns of two sympatric otter species i.e., the Smooth-Coated Otter, *Lutrogale perspicillata*, and the Asian Small-Clawed otter, *Aonyx cinereus nirnai*, were studied using 233 photographs from camera traps between March 2015 and September 2017 on the Moyar River in the Western Ghats biodiversity hotspot, India. We categorized the activity patterns of the two otter species by calculating the photo-capture rate at different seasons, and then evaluated the pooled temporal activity and overlaps by calculating the overlap coefficients. Smooth-Coated Otter temporal activity was strong late at night and before mid-day (≥ 95% records between 0100 and 1200 hours). Asian Small-Clawed Otter activity was primarily in the early morning and afternoon (≥ 95% records between 0400 and 1800 hours). We found high temporal activity overlap (Δ1≥ 0.75) between Small-Clawed and Smooth-Coated Otters (95% CI = 0.62–0.88). Temporal activity overlap was high because of morphological and ecological guild differences between these two otter species that suggest a lack of temporal niche segregation. In addition, the broad dietary breadth may compensate for the high temporal niche overlaps among these two otters. Activity pattern, and temporal niche partitioning among the sympatric otters by camera-trapping was useful to establish effective conservation measures for the aquatic carnivore conservation in the Western Ghats region.

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Keywords: Temporal activity pattern; Sympatric otters; Camera traps; Moyar River; Western Ghats; Conservation management

INTRODUCTION

Owing to their elusive nature, the current status of otter populations, resource use and activity patterns in the Indian subcontinent are inadequate (Hussain, 2013). In particular, there are few detailed otter studies from the southern Western Ghats of India (Narasimmarajan et al., 2021; Raha and Hussain, 2016; Perinchery et al., 2011 Anoop and Hussain, 2004). Studies on otter ecology have been done sporadically in India (Hussain, 1993; Sathyanarayana, 1997; Nawab, 2010; Narasimmarajan, 2020), however detailed knowledge on their activity patterns in the wild is little known (Hussain, 2013; Palei et al., 2020). Many animal species exhibit an endogenous rhythm of activity that approximates a diel cycle or twenty-four-hour period (Harker, 1964; Eisenberg, 1981). The question is whether such a rhythm is present in a semi-aquatic carnivore like otters. Smooth-coated and Asian small-clawed otters are listed as Vulnerable species under the IUCN Red list (Hussain, 1993). They are elusive animals and are listed as Schedule I species of India's Wildlife (Protection) Act, 1972 (Prater, 2005). In the Western Ghats, otters are facing pressure due to hydro-electric dams, indiscriminate fishing, illegal poaching, habitat degradation, pesticide runoff, pollution and retaliatory killing by fishermen who see otters as a competitor depleting their fish stocks (Perinchery et al., 2011; Narasimmarajan et al., 2021).

Studying temporal activity patterns of otters could help to understand their seasonal spatial movement in response to the resource availability, the potential for competition, and the optimal times to monitor the species. In this study, we measured the population status and temporal activity pattern of two Indian otter species using a broad-scale dataset collected from field surveys in the entire river and 22 camera trap locations across the Moyar riverscape, Western Ghats biodiversity hotspot, and quantify the temporal activity overlap between these two otter species.

MATERIAL AND METHODS

Study Area

The Moyar River is 102 km long. Originating in upper Bhavani at 2054 masl, it flows through several protected areas, namely Mudumalai Tiger Reserve (Mudumalai), Sathyamangalam Tiger Reserve (Sathyamangalam), Nilgiri North and South Divisions, and ends in Bavanisagar dam at 254 masl (Narasimmarajan et al., 2021; Figure 1). The upper reaches of the river receive ~5,000 mm of rainfall, whereas the downriver reaches receive ~824 mm of rainfall annually (Puyravaud and Davidar, 2013). The minimum and maximum annual average temperatures in this region vary from 14 ˚C – 30 ˚C in higher elevations, and 25 ˚C -38 ˚C in the lower elevations (Narasimmarajan et al., 2019; Puyravaud and Davidar, 2013). The elevation of the river varies from 2,054 masl (Pykara Dam) to 250 masl (Bavanisagar Dam) (Narasimmarajan et al., 2021). The Moyar landscape supports the large population of Bengal Tigers (*Panthera tigris*), Leopards (*Panthera pardus*), Asian Elephants (*Elephas maximus*), Otters (*Lutrogale perspicillata*; *Aonyx cinereus nirnai*), Indian wilddogs or dholes (*Cuon alpinus*) and endangered vultures such as *Gyps benghalensis, Gyps indicus; Neophron percnopterus*, and *Aegy piusmonachus* (Narasimmarajan, 2020; Puyravaud and Davidar, 2013).

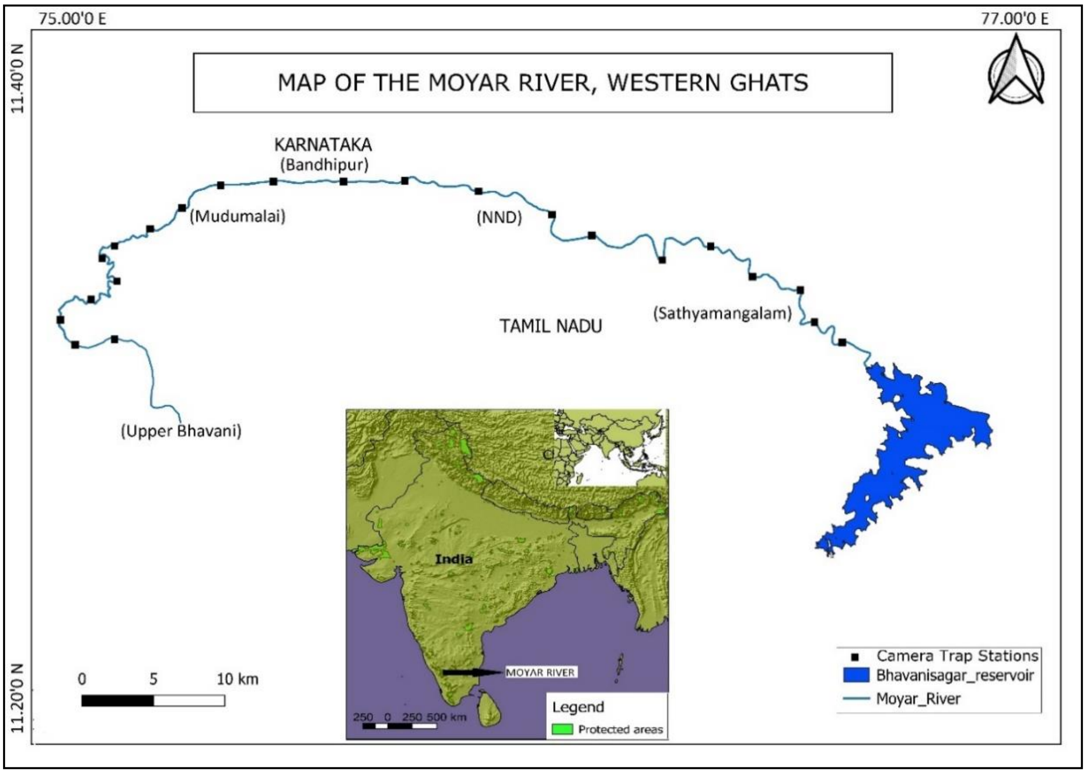

Figure 1. Location of camera traps along the Moyar River in the Western Ghats Biodiversity hotspots.

The Moyar River is an important source of irrigation for thousands of hectares of agricultural land and supports the livelihoods of more than a million people (Puyravaud and Davidar, 2013). However, this river ecosystem faces constant threats, such as agricultural pesticide runoff, hydro-electric projects, unrestricted illegal fishing activities, and the spilling of motor oil (Narasimmarajan et al., 2020). In addition, non-indigenous wattle (*Acacia melanoxylon*) and mesquite (*Prosopis juliflora*) continues to invade the river gorges, affecting catastrophically the native riparian vegetation (Narasimmarajan et al., 2021).

Study Species

Smooth-Coated Otters (*Lutrogale perspicillata*) are characterized by very smooth, sleek pelage (Figure 2A). Their eyes and ears are small, the tail is flat, limbs are short, strong, and the fore and hind paws are large and well-webbed. These otters have generally been described as fish specialists. Total body length can be up to 1.3 m and weight up to 7-11 kg. They live in pairs but are also observed in family groups of up to 3-5 individuals.

The Asian small-Clawed Otter (*Aonyx cinereus nirnai*) is the smallest otter species in the world (Figure 2B). It has short claws that do not extend beyond the pads of its webbed digits and rounded tails. Total body length of this species is around 0.50 to 0.70 m and weight up to 4.5 kg. These otters live in riverine habitats, freshwater wetlands and mangrove swamps, and paddy fields, and feed on molluscs, crabs and other small aquatic animals. They live in large family groups of up to 15-20 individuals.

Both the otter species utilise different habitats within the same aquatic ecosystem because their resource use patterns and food habits are completely divergent (Narasimmarajan, 2020).

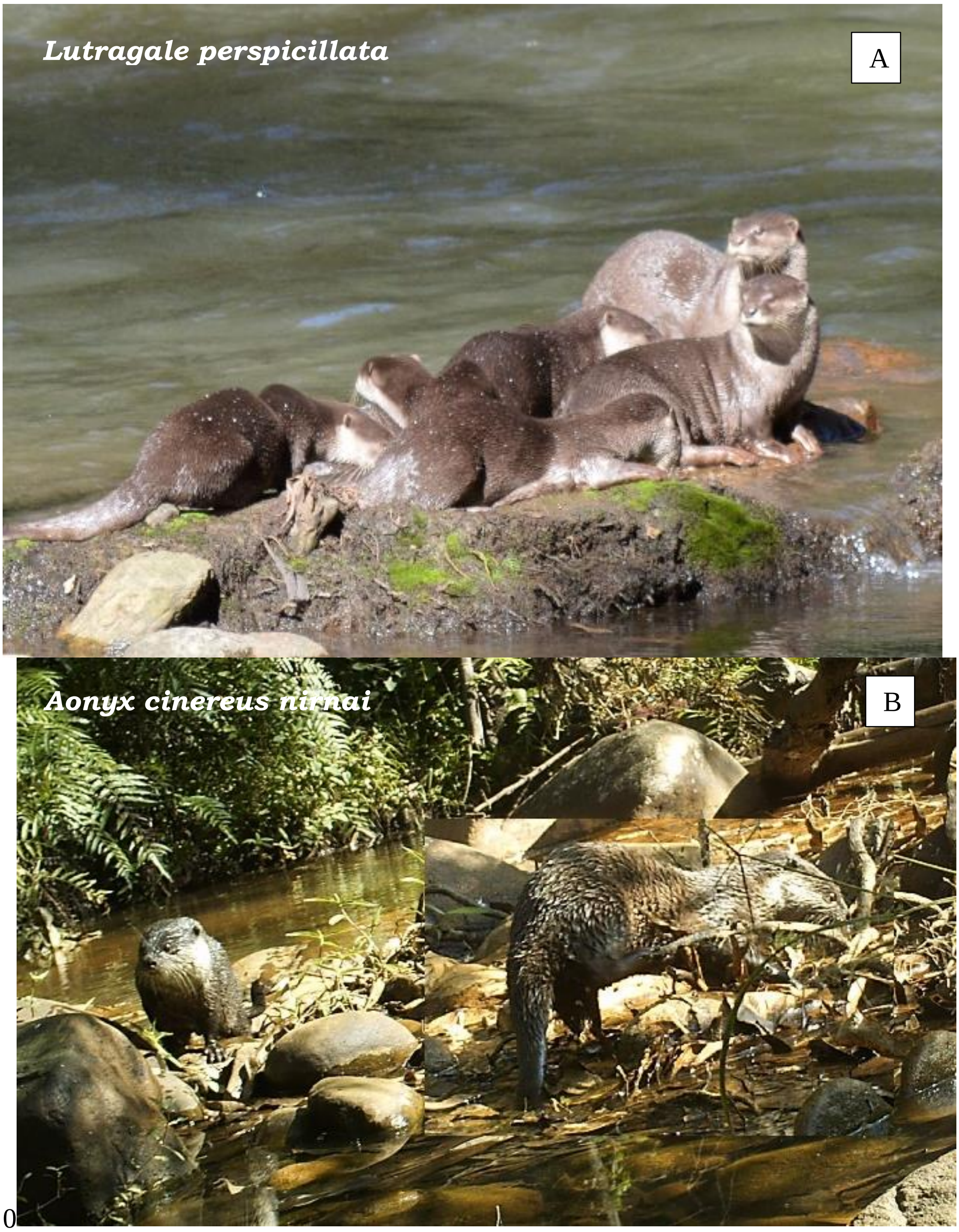

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Figure 2. A: The Smooth-Coated Otters were pictured in Mangalapatti (558 m asl) where the river was very wider and deeper, fast flowing water. **B.** The Asian small-clawed otters were pictured by camera traps at Northenhey (987 m asl) in the River Moyar where the river was very shallow water, narrow with lots of boulders.

Data Collection
Field Survey

The entire Moyar Riverbank was surveyed in post-monsoon (September - November), winter (December - February) and summer (March - June) seasons between March 2015 and September 2017, following the methods described by Narasimmarajan et al. (2021), Nawab (2010), and Hussain (1993). Whenever otters were spotted, date, species, group size, time, elevation and environmental variables were recorded in a prescribed datasheet (Narasimmarajan et al., 2021). The field data was used to estimate the seasonal population abundance of the two otter species using simple statistics (Anoop and Hussain, 2004). Population abundance was calculated using the formula:

$$P=\frac{L}{n/l \times n}$$

L = total river length; n/l = seasonal encounter rate; n = mean group size.

Camera Trap Survey

Camera trap surveys provide valuable information on species temporal activity pattern if used systematically and for a long duration (Ridout and Linkie, 2009). Each camera trap records the date and time of each photograph, which can be used to analyse the temporal activity pattern of a species in an area (Ridout and Linkie, 2009). This method has an advantage over physical trapping done for capturing small mammals as trapping records an animal's presence at some point during the period between trap setting and trap servicing, whereas camera traps provide a much longer time frame, limited only by camera memory capacity, with automatic triggering when an animal is present (Ridout and Linkie, 2009), without stress to the animal. Twelve automatically triggered cameras (Bushnell Trophy Cam 8MP HD Video Scouting Game Security Trail Camera119537C) were deployed across 22 different locations with different elevation gradients along the Moyar River (5-30-day intervals) (Table 1). The camera trap sites were selected based on high density of indirect otter evidence such as spraints, grooming sites and dens that had been observed. The temporal activity pattern of the two otter species along the river Moyar was calculated using the camera trap pictures to determine the species' activity pattern, variation and overlap in activity patterns. The cameras were operated continuously for 24 h at each site. The photo capture success rate is the ratio of independent photo events to whole camera trap days, multiplied by 100 (Rovero and Marshall, 2009). The number of independent images of otters from camera traps in the Moyar River was used to determine the season-wise photo capture rate.

Activity Pattern Analysis

Our camera-traps only recorded activity at ground-level, capture times for each species were regarded as a random sample of photographs taken at any time of a day. The day-night cycle remains constant throughout the year within the study site, mostly the sunrise occurs at 0600h and sunset at 1800h, local time (GMT +8) respectively. We estimated the daily activity pattern and temporal overlap between sympatric otter species by applying the statistical methodology developed by Ridout and Linkie (2009). We computed each species terrestrial activity pattern separately using kernel density estimation or by fitting trigonometric sum distributions (Fernandez-Duran, 2004). Then, a measure of overlap between two focal species distributions was calculated. Ridout and Linkie (2009) favoured the coefficient of overlapping, Δ, which is defined as the area under the curve that is formed by taking the minimum of the two density functions at each time point. The coefficient of overlap = 1 if the activity densities are identical and = 0 if they have no common active period.

Table 1. Information about the 22 camera-trap survey sites along the Moyar river

Site Name	Elevation (m asl)	Year	Targeted Species	Spatial Coverage (km^2)
Pykara	2054	2015-17	Otters + large mammals	8
Glanmorgon	1945	2015-17	Otters + large mammals	5
Thorapalli	1065	2015-17	Otters + large mammals	6
Northenhey	987	2015-17	Otters + large mammals	10
Melkargudi	935	2015-17	Otters + large mammals	7
Kezhkargudi	903	2015-17	Otters + Tiger, Leopard, large mammals	8
Bethamaduvu	895	2015-17	Otters + Tiger, Leopard, large mammals	12
Theppakkadu	875	2015-17	Otters + Tiger, Leopard, large mammals	7
Waterfalls	667	2015-17	Otters + Tiger, Leopard, large mammals	4
Bison camp	651	2015-17	Otters + Tiger, Leopard, large mammals	10
Moyar dam	622	2015-17	Otters + Tiger, Leopard, large mammals	12
Palthattipatti	615	2015-17	Otters + Tiger, Leopard, large mammals	12
Belimeenkadavu	602	2015-17	Otters + Tiger, Leopard, large mammals	8
Gundippatti	598	2015-17	Otters + Tiger, Leopard, large mammals	14
Gundikkadavu	587	2015-17	Otters + Tiger, Leopard, large mammals	8
Mangalapatti	558	2015-17	Otters + Tiger, Leopard, large mammals	7
Palamarapatti	523	2015-17	Otters + Tiger, Leopard, large mammals	6
Thengumaragada	503	2015-17	Otters + Tiger, Leopard, large mammals	11
Kallampalayam	497	2015-17	Otters + Tiger, Leopard, large mammals	12
Boothipatti	365	2015-17	Otters + Tiger, Leopard, large mammals	8
Kallumottai	305	2015-17	Otters + Tiger, Leopard, large mammals	4
Bhavanisagar	254	2015-17	Otters + Tiger, Leopard, large mammals	8

We obtained confidence intervals as percentile intervals from 1000 bootstrap samples. All statistics were performed in R version 2.11.1 (R Core Team, 2021) following the code made available by Linkie and Ridout (2011). We used the estimator for the coefficient of overlap because it is recommended for small sample sizes (Ridout and Linkie, 2009). Δ_1 is a label consistent with discussions in Ridout and Linkie (2009) and is defined as:

$$\hat{\Delta}_1 = \int \int_0^1 \min\left\{\hat{f}(t), \hat{g}(t)\right\} dt.$$

First, we calculated the coefficient of overlap for activity Δ_1 of the *observed data* using function overlapEst from the R package overlap (Meredith and Ridout, 2016). Δ_1 is the integral defining the area under the probability density functions of the estimated daily activity density curves of both otter species (denoted by f (t) and g (t)) (Ridout and Linkie, 2009).

RESULTS

Population Abundance of Smooth-Coated (*Lutrogale perspicillata*) and Asian Small-Clawed Otters (*Aonyx cinereus nirnai*)

A total of 14 direct sightings of Smooth-coated otters were made (59 adults and 13 juveniles) with a mean group size was 5.14 ± 0.8 individuals and the encounter rate of otter group/km was 0.18, 0.39 and 0.42 during post-monsoon, winter, and summer. A total of 8 direct sightings of Asian small-clawed otters were made (36 adults and 4 juveniles) with a mean group size of 5.77 ± 0.9 individuals and the encounter rate was 0.06, 0.18 and 0.76 during post-monsoon, winter and summer (Table 2).

Table 2. Descriptive seasonwise encounter rate and population abundance of the two otter species in the Moyar River, Western Ghats.

Smooth-Coated Otter (mean group size= 5.14 ± 0.8)			
Seasons	**Encounter rate/ km**	**Population abundance of Smooth-coated otters in the Moyar river**	
		Range (95% CI)	
Post-monsoon	0.18	92.9	95.8
Winter	0.39	201.3	207.7
Summer	0.42	216.8	223.6
Asian small-clawed otter (mean group size= 5.77 ± 0.6)			
Seasons	**Encounter rate/ km**	**Population abundance of Asian small-clawed otters in the Moyar river**	
		Range (95% CI)	
Post-monsoon	0.06	34.9	35.7
Winter	0.18	104.8	107
Summer	0.76	442.6	451.9

Photo Capture Representation of Two Otter Species

Total camera trap effort was 3917 trap-days in which the Smooth-Coated Otter accounted for 2327 trap nights and 1590 trap-days for Asian Small-Clawed Otters. The Smooth-Coated Otter photo capture rate was highest during winter but reduced gradually during summer. However, the Asian Small-Clawed Otter photo captured frequency was higher during summer but reduced after the post monsoon (Table 3).

Our observations show that both the otters were diurnal and late night in their activity behaviour. The Smooth-Coated Otter was photo-captured more during winter (36.1%), moderate post monsoon (34.7%) and less captured in summer (29.2%). The Asian Small-Clawed Otters were more frequently captured during summer (56.2%), followed by winter (33.3%) and very low in post-monsoon (10.4%).

Table 3. Photo-capture rates of otters in different seasons in the River Moyar, Western Ghats between March 2015 and September 2017.

Season	Camera-trap effort (Trap-days)	Number of otter photos captured	Otter photo capture rate/ 100 camera-trap-days
Smooth-Coated Otter			
Post monsoon	780	57	7.31
Winter	792	116	14.65
Summer	755	12	1.59
Total	**2327**	**185**	**23.55**
Asian Small-Clawed Otter			
Post monsoon	510	5	0.98
Winter	625	16	2.56
Summer	455	27	5.93
Total	**1590**	**48**	**9.47**

Temporal Activity Pattern of the Two Otter Species

In general, otters are nocturnal and very secretive in nature but in the River Moyar, the Smooth-Coated appears to be more active during late night and daylight hours i.e., late at night, mid-day and late evening hours 0100 to 1200 and 1700 to 1900 hours, and Asian Small-Clawed Otters were more active during late night and mid-day hours, 0400 to 1800 hours. Despite this, both otter species showed peak activity in the morning (Figure 3A & B).

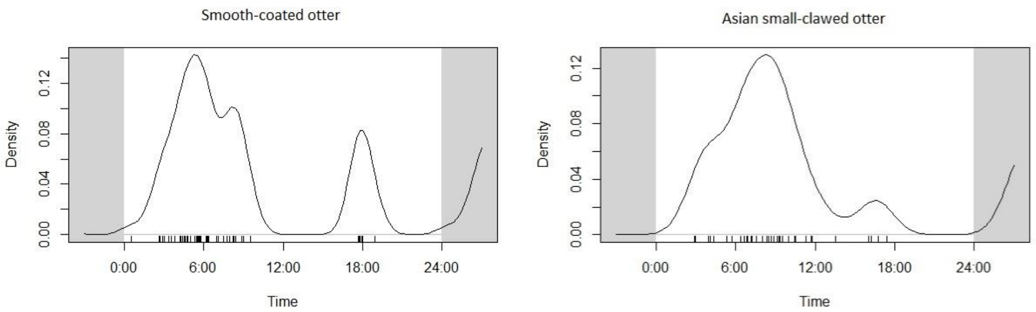

Figure 3. Kernel-density estimates of the daily activity pattern of Smooth-Coated (A) and Asian Small-Clawed (B) Otters in the Moyar River, Western Ghats biodiversity hotspot.

The activity pattern of Smooth-Coated Otters in the Moyar River exhibited a bimodal curve, in which two period of high activity were separated by a period of relative inactivity. The first active period started after late night and continued until early morning (0100 - 1200 hours), then there was a second active period which continued from approximately 1700 - 1900 hours; 1300 to 1700 and 1900 to 0100 hours no activity was been captured, perhaps due to resting in the dens. The period when inactivity was most common was 1900 - 0100 hours. The Asian-Small Clawed Otter diel activity pattern was unimodal (diurnal), with the peak activity occurring between 0400 to 1900 hours. Therefore, no activity was captured during 1900 to 0400 hours. A difference was also found between daytime and night-time activities. Estimated activity pattern overlap (Δ_1) between two otter species (1 = identical activity), with approximate 95% bootstrap confidence intervals in parentheses 0.75 (0.62 - 0.88) (Figure 4).

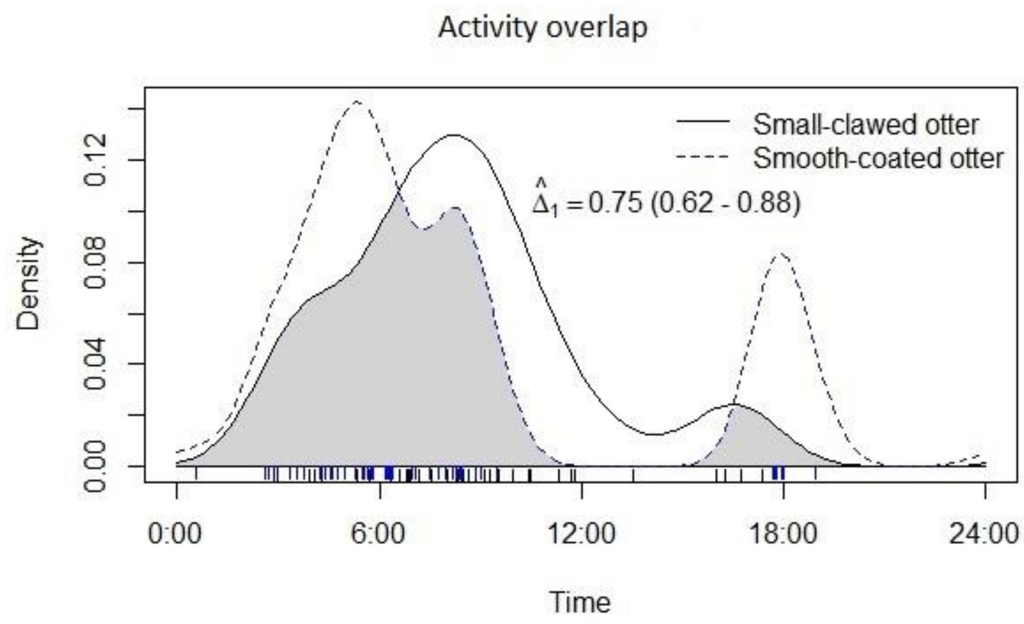

Figure 4. Temporal activity pattern and overlaps between Smooth-Coated and Asian Small-Clawed Otters in the Moyar River, Western Ghats biodiversity hotspot. The black and blue line along the horizontal axes indicates individual camera trap events containing otters and the filled grey area is overlap between the two otter species.

DISCUSSION

The present study could help better understand otter behaviour in this region. To our knowledge, this is the first field survey and camera trap-based data on encounter rate and activity patterns of two sympatric otters in their range in the Western Ghats. However, we were unable to assess the season-wise diel activity pattern of these two otter species' due to inadequate photo-capture numbers during summer for Smooth-Coated Otter and all seasons for Asian Small-Clawed Otter (Table 3). Therefore, it is difficult to compare this encounter rate with those from any other studies. Palei et al (2020) stated that the Smooth-Coated Otter showed bimodal peaks in its activity; the first peak was observed from early morning to mid-day and the second smaller was in the late afternoon. Although Smooth-Coated Otters were active throughout the day, they exhibited reduced activity during the hottest hours of the day in Bhitarkanika National Park (Palei et al., 2020). Therefore Smooth-Coated Otters in the Moyar River exhibited bimodal peaks in activity during late at night, mid-day hours with low levels of activity in the late evening. Conversely, Asian Small-Clawed Otters exhibited unimodal peaks in activity during late night to evening in River Moyar.

The findings indicate that the temporal activity patterns of Smooth-Coated Otter in the Moyar River was mainly diurnal with bimodal peak and so this study broadly differs from the results of Hussain (2013) in the River Chambal, and Wei et al. (2020) in Sabah, Malaysia Borneo, who both stated that Smooth-Coated Otters were completely crepuscular. However, the findings agree with some other Smooth-Coated Otter studies, which suggest that this species is mainly diurnal (Foster-Turley, 1992; Khan et al., 2010; Kruuk, 2006; Rosset al., 2013; Palei et al., 2020).

Conversely, the Asian small-clawed otter exhibited predominantly diurnal activity in the Moyar River, beginning in the early hours of the morning (0400 hours) and continuing to early evening (1900 hours). The increasing detections of the Asian small-clawed otters during summer could be due to the drying up of uphill stream habitats, which leads the otters to migrate towards the downriver where they find plenty of food, suitable habitat and breeding dens (Perinchery et al., 2011).

We did not record overlapping pictures of these two otter species in any of the 22 camera trap stations. This could be because the habitat requirement of these two otter species was completely divergent in the Moyar river. During the survey, three Asian small-clawed and four Smooth-coated otter active dens were seen beneath wild mango *Mangifera indica* trees. Similarly, Hewson (1969) reported that the Eurasian otters in Scotland had a positive association with Rhododendron, which occurs as a weed in many areas. This is a novel finding of the positive association between otters and wild mango trees, but further detailed study is required to understand the relationship between otters and their habitat traits, which would bring to light many more facts about social bonding and breeding biology of otters.

Conservation Implications

This paper describes the population status and activity patterns of two elusive otter species in the southern Western Ghats. The temporal activity of the two otter species is probably determined by resource availability and other environmental factors. This paper highlights the value of adopting modern scientific techniques, such as camera trapping, to help researchers and conservation agencies develop datasets to assess ethological characteristics of lesser-known elusive species.

In view of the rather unique geographical location of the Moyar River, and the corollary issues of existing dams and other anthropogenic pressure with the endangered fauna like otters, the in-place management strategies for Protected Area Management need to be re-examined (Narasimmarajan, 2020). We therefore propose that a framework based on Adaptive Management (AM) for reconciling conservation and development goals in the Moyar River ecosystem is needed. Therefore, further detailed research should be focused on otters beyond protected areas in order to have better understanding and management of the species in the human-dominated landscape. This information is critical if we are to leave future generations with the opportunities to experience nature that current generations have had (Hayward et al., 2022).

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RESUME

ÉTAT DE LA POPULATION ET MODÈLE D'ACTIVITÉ TEMPORELLE DE DEUX ESPÈCES DE LOUTRES VULNÉRABLES PROVENANT DE PIÈGES PHOTOS DANS LES HAUTS LIEUX DE LA BIODIVERSITÉ DES GHATS DU SUD-OUEST, EN INDE

Bien que l'Inde abrite le plus grand nombre d'espèces menacées, depuis le début du XXIe siècle, certaines espèces phares, comme les loutres, ont commencé à être étudiées dans leurs habitats naturels. La population et le schéma d'activité temporelle de deux espèces de loutres sympatriques, à savoir la loutre à pelage lisse *Lutrogale perspicillata* et la loutre cendrée *Aonyx cinereus nirnai*, ont été étudiés grâce à 233 photos indépendantes prises par des pièges photographiques entre mars 2015 et septembre 2017 dans la rivière Moyar, haut lieu de la biodiversité des Ghâts occidentaux, en Inde. Nous avons classé les modèles d'activité de deux espèces de loutres en calculant le taux de photo-capture durant différentes saisons et avons ensuite évalué l'activité temporelle regroupée et les chevauchements par le calcul des coefficients de chevauchement. L'activité temporelle de la loutre à pelage lisse se situe fort tard dans la nuit et avant midi ($\geq$ 95 % des enregistrements entre 01h00 et 12h00 et une activité nocturne entre 17h00 et 19h00). L'activité des loutres cendrées avait lieu tôt le matin et avant la tombée du jour ($\geq$ 95 % des enregistrements entre 4 h et 18 h). Nous avons constaté un chevauchement d'activité temporelle élevé ($\Delta 1 \geq 0,75$) entre les loutres cendrées et les loutres à pelage lisse (IC à 95 % = 0,62 à 0,88). Le chevauchement temporel des activités était élevé, en raison des différences morphologiques et écologiques entre ces deux espèces de loutres, suggérant un manque de ségrégation temporelle des niches écologiques. De plus, le large éventail de régimes alimentaires peut compenser les chevauchements temporels élevés de niches écologiques entre ces deux espèces de loutre. Le modèle d'activité et la répartition temporelle des niches écologiques entre les loutres sympatriques par piégeage photographique ont été utiles pour établir des mesures de conservation efficaces pour la conservation des carnivores aquatiques dans la région des Ghâts occidentaux.

RESUMEN

STATUS POBLACIONAL Y PATRÓN TEMPORAL DE ACTIVIDAD DE DOS ESPECIES VULNERABLES DE NUTRIA, A PARTIR DE CÁMARAS-TRAMPA, EN LOS HOTSPOTS DE BIODIVERSIDAD DE LOS GHATS SUDOCCIDENTALES

Aunque la India es hogar del más alto número de especies amenazadas, desde el comienzo del siglo veintiuno algunas especies bandera, como las nutrias, han empezado a ser estudiadas en sus hábitats naturales. Estudiamos la población y el patrón temporal de actividad de dos especies simpátricas de nutria, la Nutria Lisa *Lutrogale perspicillata*, y la Nutria de Uñas Pequeñas Asiática *Aonyx cinereus nirnai*, utilizando 233 fotografías independientes capturadas de cámaras-trampa entre Marzo de 2015 y Septiembre de 2017, en el Río Moyar del hotspot de biodiversidad de los Ghats Occidentales, India. Categorizamos los patrones de actividad de ambas especies de nutria calculando la tasa de foto-captura en diferentes estaciones del año, y luego evaluamos la actividad temporal agrupada y las superposiciones, calculando los coeficientes de superposición. La actividad temporal de la nutria lisa fue fuerte avanzada la noche y antes del medio día (≥ 95% de los registros entre las 0100 y las 1200 horas, y de la actividad, en el horario 1700 – 1900 hs). La actividad de la nutria de uñas pequeñas asiática se concentró en la mañana temprano y antes del atardecer (≥ 95% de los registros entre las 0400 y las 1800 hs). Encontramos una alta superposición temporal de la actividad ($\Delta_1 \geq 0.75$) entre las nutrias de uñas pequeñas y lisa (95% CI = 0.62–0.88). La superposición temporal de actividad fue alta, a causa de las diferencias morfológicas y de gremio ecológico entre éstas dos especies, lo que sugiere una ausencia de segregación temporal de nichos. Además, la ancha amplitud dietaria puede compensar las altas superposiciones de nicho temporal entre éstas dos nutrias. El análisis del patrón de actividad y de la partición de nicho temporal entre nutrias simpátricas mediante uso de cámaras-trampa fueron útiles para establecer medidas de conservación efectivas para los carnívoros acuáticos en la región de los Ghats Occidentales.

தமிழ்ச் சுருக்கம்

தானியங்கி புகைப்படக்கருவி புகைப்படங்களைப் பயன்படுத்தி மேற்குத்தொடர்ச்சி மலைகளில் இரண்டு நீர்நாய் இனங்களின் எண்ணிக்கை மற்றும் காலச்செயல்பாட்டு முறை பற்றிய ஆய்வறிக்கை.

இந்தியத் துணைக்கண்டம் அதிக எண்ணிக்கையிலான அழிந்துவரும் உயிரினங்களுக்கு வாழ்வலிக்கிறது என்றாலும், இருபத்தியொன்றாம் நூற்றாண்டின் தொடக்கத்திலிருந்துதான் நீர்நாய் போன்ற சில முதன்மை உயிரினங்கள் அதன் இயற்கை வாழ்விடங்கள் பற்றிய ஆய்வுகள் தொடங்கப்பட்டுள்ளன. மார்ச் 2015 மற்றும் செப்டம்பர் 2017க்கு இடைப்பட்ட காலத்தில் தானியங்கி புகைப்படக்கருவியிலிருந்து கைப்பற்றப்பட்ட 233 புகைப்படங்களைப் பயன்படுத்தி, ஸ்மூத் கோட்டட் நீர்நாய் (*Lutrogale perspicillata*) மற்றும் ஏசியன் ஸ்மால் கிளாட் நீர்நாய் (*Aonyx cinereus nirnai*) ஆகிய இரண்டு நீர்நாய்களின் எண்ணிக்கை மற்றும் காலச்செயல்பாட்டு முறை ஆய்வு செய்யப்பட்டது. வெவ்வேறு பருவங்களில் புகைப்படப்பிடிப்பு வீதத்தைக் கணக்கிடுவதன் மூலம் இரண்டு நீர்நாய் இனங்களின் காலச்செயல்பாட்டு முறைகளை வகைப்படுத்தினோம், பின்னர் ஒன்றுடன் மற்றொன்றின் குணகங்களைக் கணக்கிடுவதன் மூலம் தற்காலிக காலச்செயல்பாடுகளை மதிப்பீடு செய்தோம். ஸ்மூத் கோட்டட் நீர்நாய்களின் தற்காலிக காலச்செயல்பாடு இரவின் பிற்பகுதியிலும் நன்பகலுக்கு முன்பு வலுவாக இருந்தது (≥ 95% பதிவுகள் இரவு 0100 முதல் 1200 மணிநேரம் மற்றும் மாலை 1700 - 1900 மணிநேரங்களில் இருந்தது). ஏசியன் ஸ்மால் கிளாட் நீர்நாய் காலச்செயல்பாடு அதிகாலை முதல் மாலைவரை இருந்தது (அதிகாலை 0400 முதல் மாலை 1800 மணிநேரங்களுக்கு இடையிலிருந்தது ≥ 95%). ஏசியன் ஸ்மால் கிளாட் மற்றும் ஸ்மூத் கோட்டட் நீர்நாய்களிடையேயான (95% CI = 0.62–0.88) காலச்செயல்பாடு ஒன்றுடன் ஒன்று பிணைந்து ($\Delta_1 \geq 0.75$) இருப்பது கண்டறியப்பட்டது, மேலும் நீர்நாய்களின் காலச்செயல்பாடு ஒன்றுடன் ஒன்று

அதிகமாக இருந்தது, ஏனெனில் இந்த இரண்டு நீர்நாய்களுக்கு இடையே உள்ள உருவவியல் மற்றும் சூழலியல் வேறுபாடுகள் அவற்றிக்கிடையேயான முக்கிய வாழ்வியல் வேறுபாட்டைக் குறிக்கின்றன. கூடுதலாக மேற்குத்தொடர்ச்சி மலைப்பகுதியில் உள்ள இந்த இரண்டு நீர்நாய்களுக்கிடையே உணவுமுறையில் வேறுபாடு இருப்பது உறுதியாகிறது. நீர் நிலைகளின் பல்லுயிர்த்தன்மை பாதுகாப்பு நடவடிக்கைகளைச் செயலுக்குக் கொண்டுவர, நீர்நாய் இனங்களின் எண்ணிக்கை மற்றும் அவற்றின் காலச்செயல்பாட்டுமுறை பற்றிய இந்த ஆராய்ச்சி பெரிதும் பயனுள்ளதாக இருக்கும்.

ARTICLE

CAN YOU TELL THE SPECIES BY A FOOTPRINT? - IDENTIFYING THREE OF THE FOUR SYMPATRIC SOUTHEAST ASIAN OTTER SPECIES USING COMPUTER VISION AND DEEP LEARNING

Frederick KISTNER*[1,2], Larissa SLANEY[2,3], Nicolas MORANT[4,5]

[1]*Institute for Photogrammetry (IPF), Institute for Technology Karlsruhe (KIT), Germany*
[2]*WildTrack Specialist Group (WSG)*
[3]*Institute for Life and Earth Sciences, School of Energy, Geosciences, Infrastructure and Society, Heriot-Watt University, Edinburgh, UK*
[4]*Harvard University*
[5]*WildTrack*
**Corresponding Author: Postal Address: Photogrammetrie und Fernerkundung (IPF) Karlsruher Institut für Technologie (KIT)*
Email: frederick.kistner@kit.edu



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Abstract: Southeast Asia is home to four otter species, all with decreasing population trends. All four of Southeast Asia's otter species can coexist sympatrically and are on the International Union for Conservation of Nature's (IUCN) Red List of Endangered Species. There are knowledge gaps in the distribution range and population sizes of these elusive species, which is essential information for the implementation of effective conservation measures. Footprints can be a cost-effective, non-invasive way to collect relevant data. WildTrack has developed a Footprint Identification Technology (FIT) classification model that uses landmark-based measurements as input data. This model is highly accurate at distinguishing between three of the four otter species in Southeast Asia. In this study, we propose a deep learning-based approach that automates the classification of species by analyzing the area within bounding boxes placed around footprints. The method significantly reduces the processing time and eliminates the need for highly skilled operators placing landmark points on footprints.

To train the model, 2,562 images with 3,895 annotated footprints were used, which resulted in an impressive accuracy, precision, and recall of 99% on both training and test sets. Furthermore, the model's performance was tested on a new set of 431 footprints, which were not used in the training process, and only 4 of them were incorrectly classified, demonstrating the effectiveness of the proposed approach on unseen data. The research findings of this study confirm the viability of using a machine learning model-based approach to accurately identify otter species through their footprints. This approach is both reliable and cost-effective, which makes it an attractive tool for otter monitoring and conservation efforts in Southeast Asia. Additionally, the method has significant potential for application in community-based citizen science monitoring programs. Further research could focus on expanding the scope of the study by adding footprints from hairy-

nosed otters, as well as sympatric non-otter species, to the training database. Furthermore, this study suggests developing an object detection model and training new classification models that predict sex or re-identify individuals using a larger set of images of known (captive) individuals.
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Keywords: Eurasian otter, *Lutra lutra*, Small-clawed otter, *Aonyx cinereus*, Smooth-coated otter, *Lutrogale perspicillata*, tracks, non-invasive animal monitoring

INTRODUCTION

There are four species of otter that share the same general geographic range in Southeast Asia. These are the Asian small-clawed otter (*Aonyx cinereus*), the Eurasian otter (*Lutra lutra*), the Hairy-nosed otter (*Lutra sumatrana*), and the Smooth-coated otter (*Lutrogale perspicillata*). They are listed on the IUCN’s Red List of Endangered Species and all four species are suffering from declining population trends (Duplaix and Savage, 2018).

Otters are an important flagship species for conservation (Stevens et al., 2011) and indicator species for water and wetland health (Bhandari and GC, 2008a). Some even describe them as keystone species (Basnet et al., 2020; Bhandari and GC, 2008b). In Southeast Asia, otters face numerous threats to their survival, including habitat loss and degradation (de Silva, 2011; Foster-Turley, 1992), hunting, poaching, illegal wildlife trade (Feeroz, 2015; Soe, 2022), and climate change (Cianfrani et al., 2018), as well as pollution and human-otter conflicts (Gomez and Bouhuys, 2018; Yoxon and Yoxon, 2017). There are knowledge gaps of the distribution range and population sizes of these elusive species in Southeast Asia, which is essential information for the implementation of effective conservation measures (Duplaix and Savage, 2018).

Effective conservation efforts require knowledge of a species' distribution and abundance to understand their ecological needs and develop targeted conservation strategies. This is particularly important in areas where little or no data is available and therefore conservation needs are difficult to judge (Duplaix and Savage, 2018). Under Objective 4 of the Global Otter Conservation Strategy by the IUCN’s Otter Specialist Group, noninvasive survey methods, such as camera-trapping, spraint analysis and environmental DNA (eDNA) analysis are recommended (Duplaix and Savage, 2018). In addition, a novel, non-invasive and cost-effective PCR-RFLP eDNA method has recently been developed for otter, which relies on finding otter spraints for analysis (Sharma et al., 2022).

Despite the benefits of noninvasive survey methods, challenges remain in identifying otter species. Tracks can be a valuable and cost-effective source of noninvasive data and have the benefit that they can be collected by local communities and citizen scientists, which can enhance public awareness and engagement in conservation (Danielsen et al., 2005). They can however be difficult to find and interpret, particularly in dense or rugged environments. Even experienced field observers can misidentify tracks, with a misclassification rate of 44% reported for North American river otters (Evans et al., 2009). However, digital images of tracks can be analyzed later by an expert and, when taken in a standardized way with a scale, can be used to extract morphometric measurements for classification purposes.

WildTrack is a prominent research group in footprint identification and has published extensively on footprint analysis for many endangered and elusive species using their highly accurate Footprint Identification Technology (FIT). Several studies have demonstrated the effectiveness of morphometric analysis using digital images of tracks for species identification (S. K. Alibhai et al., 2008; De Angelo et al., 2010;

Kistner et al., 2022), sex determination (S. Alibhai et al., 2017; Gu et al., 2014; Li et al., 2018), individual identification (S. Alibhai et al., 2017; S. K. Alibhai et al., 2008, 2023; Jewell et al., 2016; Li et al., 2018), and population size estimation (S. K. Alibhai et al., 2023; Jewell et al., 2020).

In a previous study, we used morphometric measurements derived from footprints *of Lutra lutra*, *Lutrogale perspicillata*, and *Aonyx cinereus* to build an XG boost classifier and achieved an overall species classification accuracy of 91% on new unseen test data (Kistner et al., 2022).

However, even though these morphometrics models perform well with a small amount of data, they have limitations. These include the requirement of an expert to set the morphometric extraction landmark points and the inability of the model to account for variations within a species that are not represented within the previously defined measurements. To address these limitations, computer vision techniques such as convolutional neural networks (CNNs) have been utilized successfully in various wildlife conservation efforts, including age prediction of pandas (Zang et al., 2022), species identification in camera trap images (Carl et al., 2020; Wägele et al., 2022; Willi et al., 2019) and individual animal recognition (Chen et al., 2020; Hansen et al., 2018). These techniques offer advantages in speed, automation, and cost-effectiveness for species identification in conservation applications (Wäldchen and Mäder, 2018).

This study builds on previous research (Kistner et al., 2022) and investigates the possibility of distinguishing between three otter species by their footprints with a deep learning approach. Here we aim to address the limitations of previous morphometric approaches and explore the use of CNNs for the identification of otter species in Southeast Asia using digital images of tracks. As far as we know, this is the first study to use a method that combines traditional track identification with computer vision and machine learning to classify otter tracks with high accuracy, allowing for intra-species variation. We demonstrate the potential of this technique as a valuable tool for otter conservation efforts in the region by achieving accurate species identification.

METHODS

Ethics Statement

The majority of data collection for this study was carried out in zoos and otter sanctuaries by either professional wild animal keepers or under their supervision.

Keepers followed their normal working practice and followed working risk assessments. Data collection involved the non-invasive collection of digital otter footprint images found on substrates in the animals' enclosures. All animals walked across these natural substrates out of their own free will. This non-invasive approach avoided any direct contact with the animals to minimize any potential risks associated with handling them. This also ensured the animals left the footprints whilst displaying their natural behavior. Footprint data found in the field was collected after the wild otters had left the area, thus avoiding any stress on the wild animals and keeping both researchers and animals safe. Therefore, our data collection method was ethical and non-invasive, aligning with the principles of animal welfare.

Data Collection

In this study, we only used images with a known species identity. Therefore, we collected images from captive otters and added field prints from Eurasian otters in Portugal where only one species of the three is present. Smooth-coated otter prints were collected *in-situ* after visual identification of the species. In total, we received a dataset of 2,562 images from over 20 participants, each contributing one or more otter footprints. The data collection involved 17 zoos and otter sanctuaries in Germany, the UK, Austria and France. Figure 1 shows data collection of otter footprint images following the FIT protocol at a UK zoo. To ensure the quality of the images, we rated them on a scale of 1 (poor) to 5 (excellent). Most of the images were collected following the FIT protocol for collecting otter footprints (Kistner et al., 2022) and included a metric ruler for scale, but images with multiple footprints taken from various heights, some of which did not feature a scale, were also included.

Figure 1. Images of Asian small-clawed otter footprints collected at a UK zoo following the FIT protocol. Pictures are taken directly above and should contain a metric ruler. Photo credit: Woburn Safari Park, UK

Data Annotation

To annotate images, we used Hasty, a CloudFactory company, which helped us streamline the process of labeling images by creating an accurate ground truth of our data at a much faster rate. The platform's user-friendly interface and built-in tools made it easy for our team to preprocess and label the data efficiently, thereby reducing the amount of time and resources required for this crucial step in training our models. Specifically, we annotated 3,895 footprints with known species identities by placing bounding boxes around them. This included 1,138 *Aonyx cinereus*, 479 *Lutrogale perspicillata*, and 2,278 *Lutra lutra*. We annotated all four feet in the images as part of the annotation process. Figure 2 shows a screenshot illustrating data annotation in Hasty.

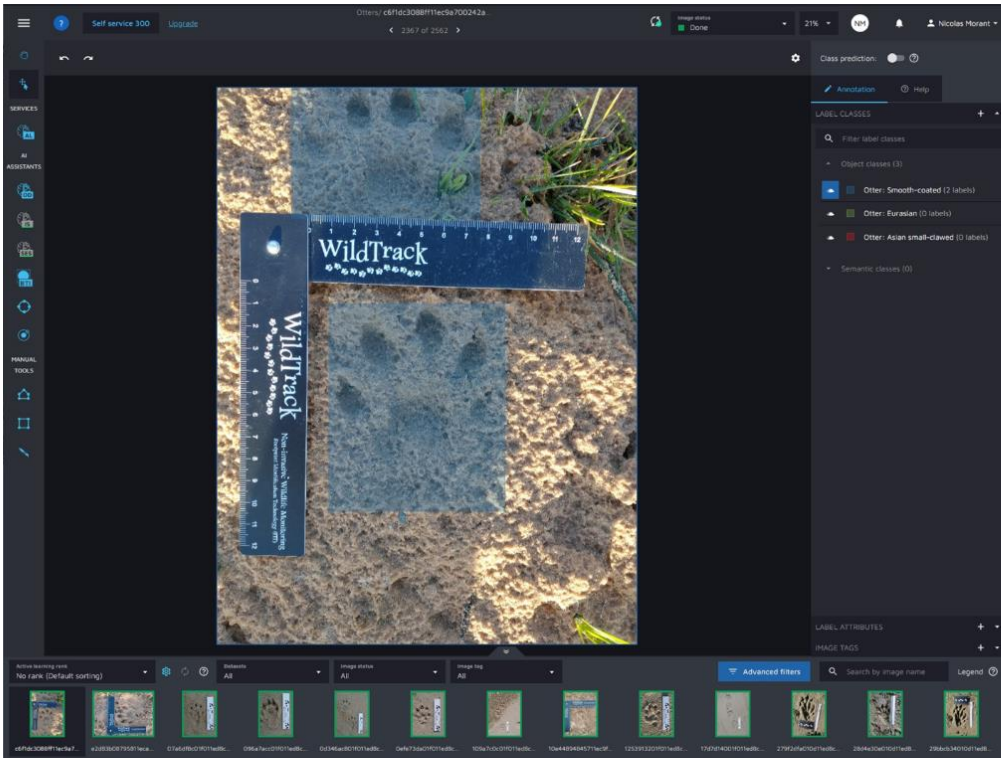

Figure 2. Bounding Box labeling of an otter footprint image using Hasty.

Model Training

Additionally, Hasty's support for a wide range of algorithms and frameworks, as well as its ability to train models on cloud-based resources, has allowed us to experiment with different approaches and find the best solution for our needs. Furthermore, the monitoring and analyzing model performance feature allowed us to track progress and identify areas for improvement. This helped us to optimize model training and ultimately improve the accuracy of our models.

We developed an image label classification model using the labeled bounding boxes containing the otters' footprints with the objective of identifying the specific otter species. By providing only the bounding boxes image area, the model could focus on this specific region of interest for making the classification more accurate. This technique is especially useful as a lot of our images contain multiple footprints within one image.

To train our models, we divided the data into three sets: a training set (80%), a validation set (10%), and a test set (10%). To ensure that our data was split in a representative manner, we employed stratification, which divided the data into approximately equal proportions of the target classes. The training set was used to train the different models, while the validation set was used to evaluate performance and optimize parameters. Finally, the test set was used to assess the overall performance of the models on unseen data.

We selected the ResNet-18 CNN architecture (He et al., 2016) due to its good trade-off between accuracy, recall, and training duration. This architecture is suitable for small datasets like ours since it has fewer parameters in comparison to other CNN architectures like ResNet34, ResNet50, or larger models, which require more resources and longer training time ultimately resulting in higher costs for model training. We used the AdamW optimizer (Loshchilov and Hutter, 2017) which uses the Adam algorithm with weight decay regularization to prevent overfitting. We also applied, as our only data transformation step, resizing the input images to 512x512 pixels. It is beyond the scope of this paper to go further into detail of CNN architecture and computational need for model training.

In addition, to improve the overall performance of our models, we tuned various hyperparameters. Firstly, we adjusted the datasets by selecting different ratings of the images used in our model. Secondly, we adjusted the base learning rate of our model to slowly tune its parameters and optimize its performance. Additionally, we used a scheduler to adjust the learning rate over time to allow our model to adjust to the changing data and improve its efficiency. Lastly, we adjusted the batch size to fine tune the model as shown in Table 1. These combined adjustments resulted in us being able to produce accurate multi-label classification models.

Table 1. Summary of model experiments with different hyperparameters under evaluation

Image Rating	Split	Base Learning Rate	Scheduler	Train Batch Size	Test Batch Size	Accuracy Train	Accuracy Val	Avg Loss Train	Avg Loss Val
5,4,3	80/10/10	0.0001	ReduceLR OnPlateau	64	24	100.00	99.66	0.00	0.01
All	80/10/10	0.0001	ReduceLR OnPlateau	64	24	99.44	99.07	0.00	0.02
5,4,3	80/10/10	0.0001	ReduceLR OnPlateau	64	24	99.75	98.99	0.00	0.01
5,4,3	80/10/10	0.0001	ReduceLR OnPlateau	64	24	99.66	97.54	0.01	0.05
5,4,3	80/10/10	0.0001	ReduceLR OnPlateau	128	24	99.44	97.64	0.01	0.05
5,4,3	80/10/10	0.001	ReduceLR OnPlateau	64	24	95.28	90.91	0.09	0.25
5,4,3	80/10/10	0.001	None	24	8	93.75	86.20	0.18	0.36
5,4,3	80/10/10	0.001	ReduceLR OnPlateau	24	8	89.92	82.15	0.30	0.54
All	80/10/10	0.001	None	24	8	91.50	63.81	0.25	1.29
All	80/10/10	0.001	None	4	1	58.17	56.15	0.95	0.95

RESULTS

Model Selection

The results of the different models are presented in Table 1, with the "Accuracy Train" column displaying the accuracy on the training data, the "Accuracy Val" column showing the accuracy on the validation data, the "Avg Loss Train" column displaying the average loss on the training data, and the "Avg Loss Val" column showing the average loss on the validation data. We selected the best model for images rated 5, 4, and 3 and the best model for all images, based on their performance on the validation set and were further evaluated on the holdout test set.

The model that performed the best for images with ratings 5, 4, and 3 had a base learning rate of 0.0001, employed the ReduceLROnPlateau scheduler, had a train batch size of 64, and a test batch size of 24. This model displayed exceptional results, achieving an accuracy of 100% on the training set, 99.66% on the validation set, and a negligible average loss of 0.00 on the training set and 0.01 on the validation set.

The best model for all images had a base learning rate of 0.0001, used the ReduceLROnPlateau scheduler, had a train batch size of 64, and a test batch size of 24. This model had a mAP accuracy of 99.44% on the training set, 99.07% on the validation set, and an average loss of 0.00 on the training data and 0.02 on the validation data. A full display of all further hyperparameters is displayed in the table above.

The model that performed the best for all images had comparable results to the model using only high-quality images. Therefore, we only present the performance of the model using all images on the test set, as it includes a broader range of images and is likely to have a greater level of generalizability.

Model Evaluation Test Set

The performance of the model on the test set, which consists of previously unseen data, is displayed in this confusion matrix (Figure 3). It illustrates the number of accurate and inaccurate predictions made by the model for each species. For instance, the model correctly identified 40 instances of the Otter: Smooth-coated species, and it made one misclassification of this species. Additionally, it correctly identified 242 instances of the Otter: Eurasian species and had no incorrect predictions of this species. Likewise, it correctly identified 145 instances of the Otter: Asian small-clawed species but made 3 erroneous predictions of this species. Examples of these predictions are shown in Figure 4. Figure 5 is a saliency map, illustrating an exemplary visual representation of regions of importance for the classification model within this particular footprint.

In conclusion, the model's performance on the test set is relatively strong, with a high number of correct predictions for each species, but it also highlights the need for potential improvements in regard to the low number of incorrect predictions.

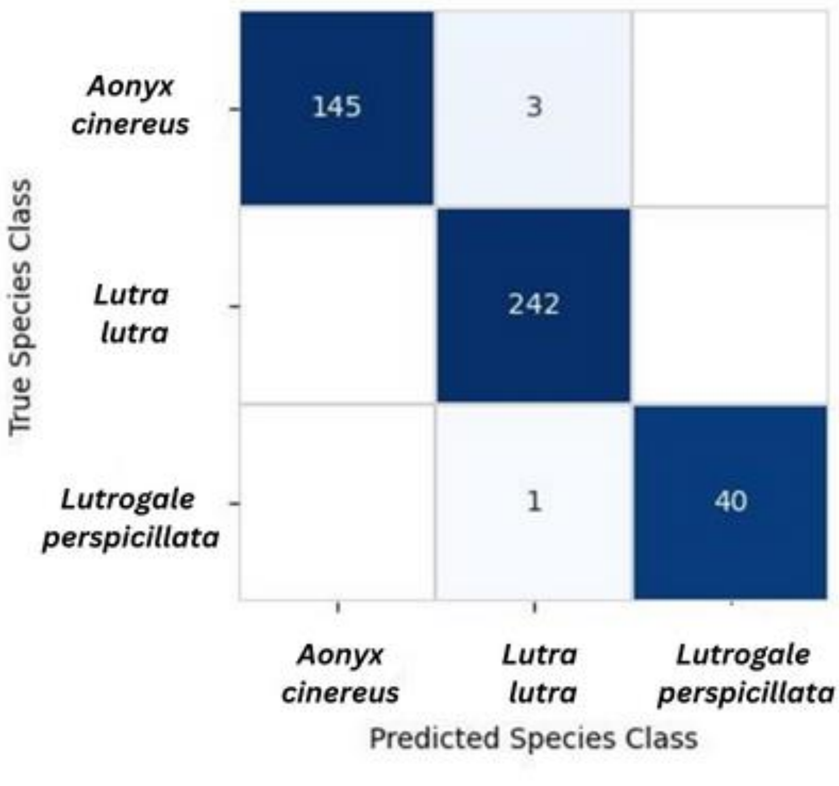

Figure 3. Confusion matrix for our best image classification model on unseen data: evaluating model performance

True Label:	Otter: Eurasian	Otter Smooth-coated	Otter: Asian small-clawed
Predicted Label:	Otter: Eurasian	Otter Smooth-coated	Otter: Asian small-clawed
Confidence:	100%	100%	98%

True Label:	Otter: Eurasian	Otter: Smooth-coated	Otter: Asian small-clawed
Predicted Label:	Otter: Eurasian	Otter: Smooth-coated	Otter: Asian small-clawed
Confidence:	100%	100%	100%

Figure 4. Predictions on unseen data using our best image label classification model.

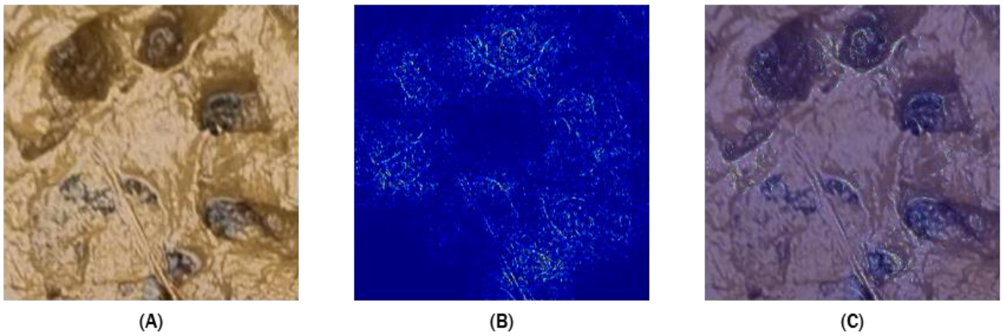

Figure 5. Saliency map overlay on the original image. (A) Original image of a right front footprint from an Asian small-clawed otter. (B) Saliency map highlighting the most visually salient regions of the image. (C) Overlay of the saliency map on the original image, emphasizing the most visually significant regions of the footprint. The saliency map was generated using our best model. The overlay provides a clear visualization of the model output, highlighting the regions that help to predict and classify the otter species.

Table 2 displays the performance of the top model on the test set, which was trained using all images. The first column displays the number of times the model correctly identified each species (True Positive count). The second column displays the number of times the model incorrectly identified each species (True False count). The third column displays the number of times the model failed to identify each species (False Negative count). The fourth column shows the precision of each species, which is the percentage of correctly identified instances among all instances that were identified as that species. The fifth column shows the recall of each species, which is the percentage of correctly identified instances among all instances that actually belong to that species. The sixth column shows the micro-averaged F1 score, which represents the overall performance of the model. The seventh column shows the macro-averaged F1 score, which represents the model's performance across all species. The last column shows the weighted F1 score, which takes into account the relative importance of each species. The model performed well overall, with all the above metrics achieving a score of 0.99.

Table 2. Best Model (All Images) Classification Performance Table on Unseen Data

	TP	TF	FN	Precision	Recall	Micro F1	Macro F1	Weighted F1
Model	427	4	4	0.99	0.99	0.99	0.99	0.99

Table 3 shows the performance of our top classification model, which was trained on all images, in identifying three of the four Southeast Asian otter species. It reveals that the model has a high level of precision and recall for each species. The F1-Score, a measure of the balance between precision and recall, is also high, which means that the model is performing well in both identifying the species and minimizing false identifications. Overall, the table indicates that the model is effectively distinguishing between the three different types of otter species.

Table 3. Best Model (All Images) Classification Performance Table on Unseen Data

	Precision	Recall	F1-Score
Otter: Smooth-coated	0.98	1.00	0.99
Otter: Eurasian	1.00	0.98	0.99
Otter: Asian small-clawed	0.98	1.00	0.99

DISCUSSION

The recent Malaysia Otter Workshop 2022, jointly organized by the Malaysia Otter Network, Malaysian Nature Society and the International Otter Survival Fund, highlighted the need for conducting otter surveys across Southeast Asia in light of the pressing issues of habitat degradation, pollution, human-otter conflict and the illegal trade of otter pets and fur (Yoxon, 2022). Given the scarcity of precise information on otter species distribution, it is crucial to carry out official and accurate surveys.

Our study demonstrates that using this non-invasive, low-cost and effective method of standardized, machine-learning-based footprint analysis provides an accurate survey method. Furthermore, to enhance the quality and quantity of available data, engaging local communities, especially those with Traditional Ecological Knowledge (TEK), could be a valuable approach. By incorporating the insights of these communities, a more comprehensive understanding of the current status of otters in the region could be attained.

Accurate baseline data is crucial for conservation efforts, but identifying elusive species like otters can be challenging. To tackle this challenge, we have developed a promising novel approach that leverages the advantages of CNN-based computer vision and ResNet models for identifying otter species using their footprints. Our approach has yielded promising results, outperforming our previous study (Kistner et al., 2022) in terms of performance scores on a larger dataset as well as reducing the time required for data labeling. Our study found that it is possible to distinguish between three sympatric otter species by analyzing their footprints using a partially automated computer vision approach. Furthermore, we believe the use of bounding boxes instead of morphometric landmark points has potentially reduced operator bias, thereby enhancing the reliability of our findings. We are optimistic that this innovative technique can pave the way for more effective monitoring and conservation of otters and other elusive species, while linking with TEK across communities globally, and linking in-situ and ex-situ species conservation and research. However, it should be noted that our current model is limited to predicting the three otter species it is trained on, even if a track originates from a non-otter species. To overcome this limitation, future research could focus on training the model on a comprehensive regional database that includes tracks and signs of all species present in that specific region. Alternatively, a model could be developed to identify new classes once the data discrepancy reaches a certain threshold. Additionally, our approach is not entirely automated, as bounding boxes need to be manually set. Future research could enhance the methodology by incorporating object detection, footprint quality, and scale estimation models built into an entire machine learning pipeline, enabling a fully automated method. The integration of such an approach into a smartphone-based application with inference could potentially enhance user experience.

On the technical side, future research could explore the minimum quality criteria for footprints necessary for successful application of our approach. Additionally, our technique could be extended to benefit other species beyond otters, and data collection could involve not only professional trackers and zoos, but also local/indigenous people and citizen scientists. The participation of indigenous people and locals in conservation efforts is essential as they are key stakeholders in these areas and their involvement could potentially lead to job creation and the incorporation of Traditional Ecological Knowledge (TEK) into conservation initiatives (Danielsen et al., 2014; Ponce-Martins et al., 2022). This would not only foster greater community engagement but also promote the preservation of local ecosystems and their biodiversity.

From an ecological perspective, our approach could be used to look for new target classes, such as sex, age class, and individual identification, as demonstrated previously for other species with morphometrics (S. Alibhai et al., 2017; S. K. Alibhai et al., 2023; Jewell et al., 2016, 2020; Li et al., 2018). For instance, we could integrate hairy-nosed otters for the Southeast Asian region, create a method for individual identification, and develop an approach for other otter species. Footprint analysis could also aid in mitigating human-otter conflict by identifying the specific otter species or even the individual otter that is part of the conflict situation, such as conflict with commercial and subsistence fish farming (Duplaix and Savage, 2018; Shrestha, M.B., Shrestha et al, 2022) This would not only facilitate better management of human-otter interactions but also enhance our understanding of otter behavior and ecology.

CONCLUSION

In conclusion, our approach has significant potential to improve our understanding of otter species distribution and behavior, thus providing valuable insights for conservation efforts aimed at safeguarding these charismatic and ecologically important species. By enabling more accurate and efficient identification of otter species, our approach could potentially facilitate more targeted conservation strategies, such as habitat protection and restoration, and the identification and mitigation of threats like pollution and poaching. Ultimately, this could help to preserve these animals' populations and the ecosystems they inhabit for future generations.

Currently, public use of the model is not possible due to concerns about protecting endangered species from potential misuse by poachers. However, we are working on developing a secure platform where verified biologists can register, submit images for inference, and receive results within seconds. In the future, this functionality will also be available through a mobile app, even in areas without internet access. This development is still in progress and will take time before it becomes available to users.

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RESUME

POUVEZ-VOUS RECONNAÎTRE UNE ESPÈCE A SON EMPREINTE ? - IDENTIFICATION DE TROIS DES QUATRE ESPÈCES DE LOUTRES SYMPATRIQUES D'ASIE DU SUD-EST À L'AIDE DE LA VISION PAR ORDINATEUR ET DE L'APPRENTISSAGE EN PROFONDEUR

L'Asie du Sud-Est abrite quatre espèces de loutres, présentant toutes une tendance démographique à la baisse. Les quatre espèces de loutres d'Asie du Sud-Est peuvent coexister en sympatrie et figurent sur la Liste rouge des espèces menacées de l'Union Internationale pour la Conservation de la Nature (UICN). Il existe des lacunes dans les connaissances de l'aire de répartition et la taille des populations de ces espèces furtives, informations essentielles à la mise en œuvre de mesures de conservation efficaces. Les empreintes peuvent constituer un moyen rentable et non invasif de collecter des données pertinentes. Wild Track a développé un modèle de classification de la Technologie d'Identification des Empreintes (TIE) qui utilise des mesures basées sur des points de repère comme données de départ. Ce modèle est très précis et permet de distinguer trois des quatre espèces de loutres d'Asie du Sud-Est. Dans cette étude, nous proposons une approche basée sur l'apprentissage en profondeur qui automatise la classification des espèces en analysant la zone des points de repère de délimitation placés autour des empreintes. Le procédé réduit considérablement le temps de traitement des données et permet de se passer d'opérateurs hautement qualifiés pour la localisation des points de repère sur les empreintes.

Pour tester le modèle, 2.562 images comportant 3.895 empreintes annotées ont été utilisées, ce qui a abouti à une exactitude, une précision et un retour impressionnants de 99 % sur les groupes d'entraînement et de test. De plus, les performances du modèle ont été testées sur un nouveau groupe de 431 empreintes, qui n'ont pas été utilisées dans le processus de formation, et seulement 4 d'entre elles n'ont pas été bien identifiées, démontrant l'efficacité de l'approche proposée sur des données inconnues. Les résultats de cette étude confirment la viabilité d'utilisation d'une approche basée sur un modèle d'apprentissage automatique pour identifier avec précision les espèces de loutres grâce à leurs empreintes. Cette approche est à la fois fiable et rentable, ce qui en fait un outil attrayant pour les efforts de suivi et de conservation des loutres en Asie du Sud-Est. De plus, la méthode présente un potentiel d'application important dans les programmes communautaires de suivi scientifique citoyen. Des recherches plus approfondies pourraient se concentrer sur l'élargissement de la portée de l'étude en ajoutant à la base de données de formation des empreintes de loutres de Sumatra ainsi que d'espèces sympatriques autres que les loutres. En outre, cette étude suggère de développer un modèle de détection d'objets et de former de nouveaux modèles de classification qui prédisent le sexe ou ré-identifient les individus à l'aide d'un plus grand nombre de représentations d'individus connus (en captivité).

RESUMEN

¿SE PUEDE DIFERENCIAR ESPECIES MEDIANTE UNA HUELLA? - IDENTIFICACIÓN DE TRES DE LAS CUATRO NUTRIAS SIMPÁTRICAS DEL SUDESTE ASIÁTICO UTILIZANDO VISIÓN POR COMPUTADORA Y APRENDIZAJE PROFUNDO

El Sudeste Asiático es hogar de cuatro especies de nutria, todas con tendencias poblacionales decrecientes. Las cuatro especies de nutria del Sudeste Asiático pueden co-existir simpátricamente y están en la Lista Roja de Especies Amenazadas de la Unión Internacional para la Conservación de la Naturaleza (UICN). Hay vacíos de conocimiento del área de distribución y los tamaños poblacionales de éstas especies elusivas, y ésa es información esencial para la implementación de medidas de conservación efectivas. Las huellas pueden ser una manera no invasiva y de bajo costo para colectar datos relevantes. WildTrack desarrolló un modelo de clasificación mediante Tecnología de Identificación de Huellas (TIH; FIT en inglés), que utiliza mediciones de puntos de referencia como datos de entrada. Éste modelo es altamente preciso para distinguir entre tres de las cuatro especies de nutria en el Sudeste Asiático. En éste estudio, proponemos un enfoque basado en aprendizaje profundo, que automatiza la clasificacióno de las especies analizando el área dentro de cuaddros delimitadores mínimos posicionados alrededor de las huellas. El método reduce significativamente el tiempo de procesamiento y elimina la necesidad de operadores altamente calificados que posicionen los puntos de referencia en las huellas.

Para entrenar al modelo, utilizamos 2.562 imágenes con 3.895 huellas, lo que resultó en una exactitud, precisión y sensibilidad impresionante, del 99% tanto en el entrenamiento como en los sets de prueba. Más aún, la performance del modelo fue testeada en un nuevo conjunto de 431 huellas, que no habían sido usadas en el proceso de entrenamiento, y solamente 4 de ellas fueron clasificadas incorrectamente, demostrando la efectividad del enfoque propuesto con datos no vistos previamente. Los hallazgos de este estudio confirman la viabilidad de utilizar un enfoque basado en modelos de aprendizaje automático para identificar especies de nutria con exactitud a través de sus huellas. Éste enfoque es confiable y de bajo costo, lo que lo hace una herramienta atractiva para el monitoreo de nutrias y los esfuerzos de conservación en el Sudeste Asiático. Además, el método tiene significativo potencial para ser aplicado en programas de monitoreo basados en ciencia ciudadana en comunidades. Ulteriores investigaciones podrían enfocarse en expandir el objeto de estudio agregando huellas de Nutria de Sumatra, así como especies simpátricas que no sean nutrias, a la base de datos de entrenamiento. Más aún, éste estudio sugiere la conveniencia de desarrollar un modelo de detección de objetos y entrenar nuevos modelos de clasificación que predigan el sexo ó re-identifiquen individuos utilizando un conjunto mayor de imágenes de individuos conocidos (de cautiverio).

REPORT

DISTRIBUTION PATTERN, THREATS AND USE OF SPOTTED-NECKED OTTERS (*Hydrictis maculicollis*) IN THE RIVERINE COMMUNITIES OF ONDO STATE, NIGERIA

Olalekan SALAMI

Department of Ecotourism and Wildlife Management, School of Agriculture and Agricultural Technology, Federal University of Technology, Akure, Ondo State, Nigeria.
e-mail: salamiolalekan92@gmail.com

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Abstract: The goal of the research is to assess the distribution pattern, threats, and use of Spotted-necked Otter, *Hydrictis maculicollis,* in the riverine areas of Ondo State, Nigeria. Field observations were conducted by walking transects along the banks of the rivers as well as the use of a speedboat/canoe on the water bodies. Focus group discussions (FGD) and key informant interviews (KII) were used to facilitate the research. A total of 51 groups of fishermen/farmers from 17 communities in Ilaje, Irele, Ese-Odo, and Okitipupa local government areas were interviewed. Key informant interviews were carried out where Focus group discussions could not be conducted. These were audio-recorded, after which they were transcribed and analysed qualitatively using thematic analysis. Spotted-necked showed wide distribution in the freshwater ecosystems along the riverbanks, marshy areas, swamps, and streams based on the presence of their indices in the area. During the survey, one dead otter was observed from a fisherman at Olopo, and about 12 skulls and over 500 nets damaged by otter were confirmed in the major river (River Oluwa) and its tributaries in the riverine communities. Direct hunting, with more than 65 set traps, was observed during the survey and accidental capture as well as noise pollution by speedboats was observed in 15 riverine communities as major threats to otter. Increasing demand for otter meat in local restaurants, trade in body parts, and use for traditional medicine in the region pose serious threats to otter populations if not addressed.

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Keywords: Habitat, Occurrence; Spotted-necked otter; Threats; Uses; Ondo State

INTRODUCTION

Otters belong to Order Carnivora and Family Mustelidae (Ketmaier and Bernardini, 2005). They are a distinct group of carnivores because of how well they have adapted to a semi-aquatic lifestyle (Kruuk, 2006). They also are an important species in wetlands and one of the main predators in aquatic habitats (Ottino and Giller, 2004). There are 13 living species of otters worldwide, three of which are only found in Sub-Saharan Africa (Lelias et al., 2021). Spotted-necked otters can be found in lakes and bigger rivers over much of southern Africa, and they are thought to be extinct in Burundi, Ghana, Lesotho, and Togo (Reed-Smith et al., 2015). Nigeria is home to two species of otters; the African Clawless otter *Aonyx capensis* and the Spotted-necked otter *Hydrictis maculicollis*. *A. capensis* is found in north-western Nigeria, in theregion of Kainji Lake and Borgu Game Reserve, where it shares habitat with the Spotted-necked otter. *A. capensis* have been observed in Calabar's rainforest and the Guinean savannah (Francesco et al., 2005). They are constrained to permanent bodies of freshwater with sufficient shoreline cover and a plentiful prey base (Skinner and Chimimba 2005). Signs of presence have always been recorded close to the water's edge (Procter, 1963).

The existence of the species is threatened by several issues. Hunting is prevalent in India, and the country is the greatest supplier of otter killed, mostly to meet the enormous demand in the Chinese market (Gomez et al., 2017). Skinner and Chimimba (2005) reported direct and indirect persecution and, perhaps, hunting have an impact on the range of Spotted-necked otters, while also aggravating the loss and deterioration of habitat. Most otters are subject to risk of illegal killing due accidental capture in nets (Harrington et al., 2017). Climate change will seriously affect otters due to their dependence on rivers, lakes, streams, and riparian vegetation for shelter as well as the possible reduction in water levels and droughts as a result of global warming.

Otters are killed all over Africa for their meat, skins, and for medicinal purpose (Reed-Smith et al.,2015). In both rural and urban markets in African towns and cities selling plants and animals for medicine is prevalent (FAO, 2007). The penis of otters was reported to be crushed and mixed with coconut milk to enhance virility (Dong et al., 2010). Otter bile was once used in China to cure anaemia and irregular menstruation (Wang and Carey, 2014).

The Spotted-necked otter is listed on CITES Appendix II (www.cites.org) and classified as Near-threatened with a declining population on the IUCN Red List (Reed-Smith et al., 2015).The range of otters in Nigeria is largely unknown, and information about them comes from museum specimens from a time when this region's overall ecological characteristics were very different from those of today (Francesco, 2005).In Nigeria, both the African clawless otter and the Spotted-necked otter are very rare, and possibly declining. Little work has been done on the ecology and conservation of the Spotted-necked otter in theSouth West area of Nigeria.Therefore, this research aims to assess the distribution pattern of Spotted-necked otters as well as threats and uses in the riverine area of Ondo State, which will help in further inventory and conservation of the species.

MATERIAL AND METHODS

Study Area

The research was conducted in the coastal areas of Ondo State, which is in Nigeria's Southwest region between Latitude 5° 50' N - 6° 09' N and Longitude 4° 45' E - 5° 05' E. Ondo State's coastline is around 180 km long. The watershed encompasses an area larger than 2000 km^2. It consists of four local government areas. Okitipupa local government is the most populous in this research region, with a population of 234,138 and a land area of 803 km^2. They are Ikales-speaking people. Ilaje local government has a land area of 1,318 km^2 and is the largest local government in Ondo State in terms of population (129,795). They are part of the Ilaje ethnic group. Ese-Odo local government has an area of 762 km^2 and a population of 158, 256 people from the Ijaw and Apoi ethnic groups. The Irele local government has the fewest people (144,136)

and the smallest area (963 km^2). They communicate in Ikales (National Bureau of Statistics, 2010) (Fig. 1). Commercial activities in these areas are carried out in speedboats and canoes used for transportation of goods and people, petroleum exploration, and the boat building industry (NIPOST, 2017) while fishing and agriculture are the primary occupations of the locals (Kabir et al., 2020).
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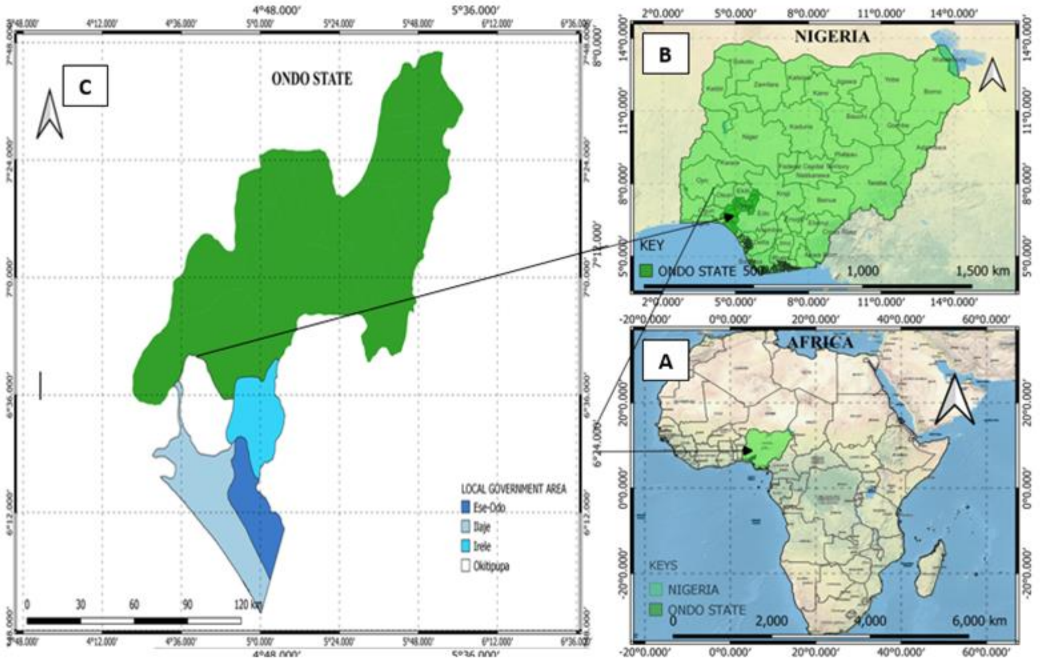

Figure 1. A: The location of Nigeria in Africa, **B:** The location of Ondo State in Nigeria, **C:** Map of the study area, showing the local government areas in the riverine area of Ondo State, Nigeria (Salami et al., 2022).

Climate and Biodiversity of the Coastal Areas of Ondo State

The riverine regions have a tropical climate with rainy (April to October) and dry seasons. The typical temperature is 28°C during rainy season, and the average rainfall index is around 3000mm. With a mean temperature of 32 °C and an average rainfall index of 800mm for the dry season (Adesina and Ogunseiju, 2017). The region is drained by several perennial streams and rivers, which pass through several coastal communities before emptying the ocean via an estuary with a water exchange between the coast and the shoreline (Agunbiade et al., 2010). The predominant kind of vegetation in this region is mangrove swamp, particularly the red mangrove *Rhizophora racemose* and the white mangrove *Avicenniaspp* typical of swamps. Two to ten months of the year, the area is exposed to tide change and salt water incursion. There are three subzones that border the coastal marshes and creeks; freshwater, brackish water and saltwater (Bolarinwa et al., 2016). The coastal areas are estimated to be about 60,000 hectares in size, rich in biodiversity and home to a variety of fish, shellfish, finfish species, amphibians, reptiles, mammals and other aquatic animals (Solarin et al., 2010).

Data Collection

To estimate the presence of Spotted-necked otters in the area, a reconnaissance survey (February 2020 was conducted among fishermen and farmers as well as individuals in the communities that routinely utilize the coastline and have potential encounters with otters (Fig. 2A,B). This method is appropriate for assessing the relative abundance of some rare species and has been used to measure the abundance of other wild mammals in the hunting terrestrial system (van der Hoeven et al., 2004).


Figure 2A: (right) Focus group discussion at Ode-Iyansan. Source: Field survey, 2021
Figure 2B: (left) Key Informant Interview at Akotogbo. Source: Field survey, 2021

Field Observations

Field observations were conducted by walking transects along the banks of the rivers as well as by speedboat or canoe on the water bodies from 6.00am to 11.00am, 3:00pm to 6:00pm and 8:00pm to 10:00pm for 30 days. This involved walking along the river banks to observe otter activities as well as possible threats to its survival. The surveyswere carried out both during the day (to look for otters and signs of their presence) and at night using torchlight (to look for active individuals). The GPS coordinates of the distribution pattern of otters in the study area were taken to generate a distribution map for the species (Fig. 3).

Focus Group Discussions and Key Informant Interviews

Focus group discussions (FGD) and key informant interviews (KII) were used to facilitate the research in 2021. Respondents who had fished for more than 10 years as well as those who work in the aquatic milieu were selected. Subjects included whether respondents had ever seen otters in the area, in what kind of habitat, main activities observed, threats to the otters and use of otter. For ease of identification, otter pictures were displayed to responders, and a native interpreter was used to translate the questions into Ijaw language during the discussions among the Ijaw communities. A total of 51 groups of fishermen/farmers from 17 communities in the four local government areas were interviewed. Key informant interviews were carried out where Focus group discussion could not be conducted. The following communities were selected for the survey;Aboto, Akata, Ipare, Laradha, Olopo and Lekki meta were selected from Ilaje. Agadagba, Arogbo, Enikorogha, Igbekebo and Igbotu were selected from Ese-odo; Akotogbo, Ode Iju-osun and Ode Iyansan were selected from Irele while Erinje, AraromiAyeka and Oloto communities were selected from Okitipupa Local Government Area (Figure 2A,B, Table 1).

Data Analysis

Data on the Focus Group Discussions and Key Informant Interviews were audio-recorded, after which it was transcribed and analysed qualitatively using thematic analysis.

Table 1. Selection process, variables and rationale for the Focus group discussion and Key Informant Interviews in the riverine areas of Ondo State

Table Methods	Participants	Selection Criteria and Rationale	Theme	Description of Themes
Key Informant Interview/ Focus Group Discussion	• Fishermen • Farmers • Boat/canoe transporters • Market women • Chiefs • Associations/ Groups	10 years and above experience in fishing/farming or work in the aquatic milieu.	• Distribution patterns	Types of habitats, season and frequency of occurrence
			• Threats	What are the threat factors, causes of death and trends in otter numbers
			• Uses	Economic, traditional and medicinal values of otters

RESULTS

Otter Distribution pattern

The presence of Spotted-necked otter was observed in all the coastal communities sampled (Fig. 3). All the interviewees confirmed to have seen Spotted-necked otter directly in and around the rivers, swamps, streams, and marshy areas as well as indirectly through observation of destroyed nets, partially eaten fish in nets, spraint in forested areas, on logs, and near river banks. Most interviewees confirm to have seen otters primarily in the morning and evening especially during the raining season (Table 2). Otters were generally called “Lombo” among the Ilajes regardless of species and “Okosi” in Ijaw dialect.

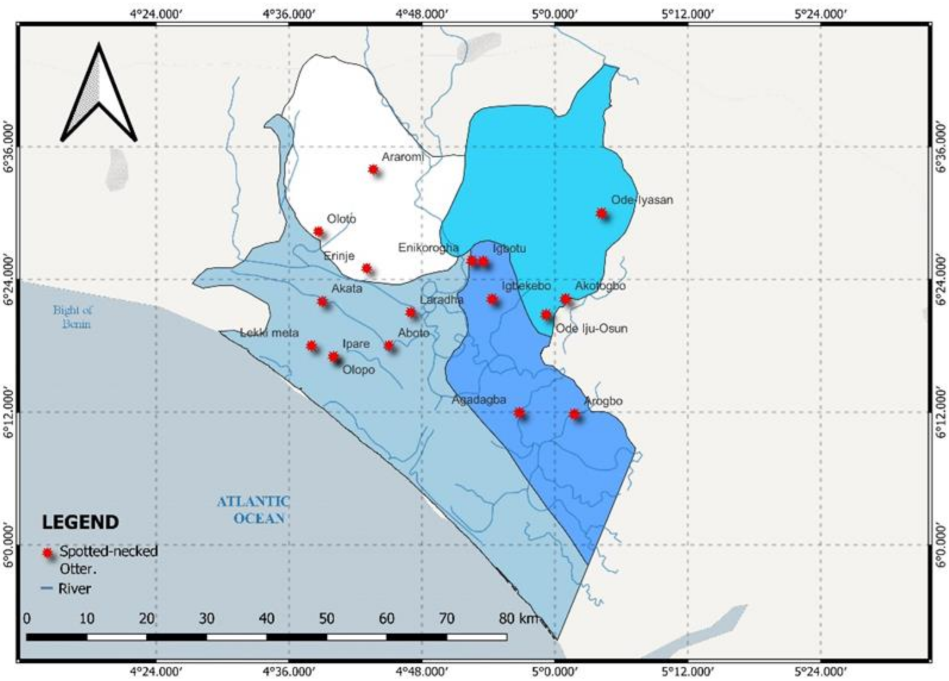

Figure 3. Spatial distribution of spotted-necked otter in the study area (Salami et al., 2022).

Table 2. Signs of Spotted-necked Otter in the Study Areas

Sign	Means of Identification	Subjective Response	Objective Response
• Dead Otter	Field Observation and Focus group discussion/Key Informant Interview	95% of the interviewees confirmed to have seen dead otter before.	A dead spotted-necked otter was observed from a fisherman at Olopo during survey (Fig. 4). More than 12 otter skulls were seen during the survey (Fig. 5).
• Otter parts	Field Observation and Focus group discussion/Key Informant Interview	82% of the interviewees confirmed to have seen otter parts especially the skulls from hunters/fishermen and market women.	Not encountered during survey
• Sprraints	Field Observation and Focus group discussion/ Key Informant Interview	94% of the interviewees agreed to have seen Otter spraints in the area while 6% of the interviewees said they have not seen Otter spraints before.	Not encountered during survey.
• Torn Nets	Field Observation and Focus group discussion/ Key Informant Interview	100% of the interviewees agreed to have observed Otter torn fishing nets.	Over 500 damaged nets was observed through walking transect along the river banks in all the communities surveyed
• Footprints/Tracks		18% of the interviewees agreed to have seen the footprint of Otter 82% of the interviewees disagreed.	

Source: Field Survey, 2021.

Figure 4. Dead Spotted-necked otter at Ipare (Salami et al., 2022).

Figure 5. Skulls of Spotted-necked otter at Enikorogha. Source: Field survey, 2021.

Threat factors associated with spotted-necked otters in the riverine area of Ondo State

The data indicate that "Direct hunting" is a major threat to Spotted-necked otter in the coastal regions of Ondo State (Table 3).

Table 3. Threat Factors associated with Spotted-necked Otter in the Study Area

Threats Faced	Means of Identification	Subjective Response	Objective Response
Direct hunting	Field Observation and Focus group discussion	100% of the interviewees agreed that direct hunting is a major threat to Otter.	More than 65 different types of traps set around the riverine areas were observed through walking transect along the river banks
Accidental catch	Field Observation and Focus group discussion	24% of the interviewees agreed while 76% were undecided.	Not encountered during survey.
Noise pollution	Field Observation and Focus group discussion	24% of the interviewees agreed while 88% of the interviewees were undecided.	Noise pollution from speedboats were observed in 15 communities during survey.

Source: Field Survey, 2021

Ilaje Local Government Area

In Okoha Igbokoda, all the interviewees considered spotted-necked otter, called "Igun" in Ilaje dialect, as a natural enemy because of the degree and severity of damage to their fishing nets as well as reduction in income due to depredation on fishes within the nets.An interviewee at Olopo confirmed the killing of a Spotted-necked otter in February, 2021 with his dog. In Ipare, spotted-necked otter is often hunted, particularly by the fishermen and farmers in the area, using traps, nets and guns.

Ese Odo Local Government Area

In Igbekedo, Spotted-necked otter was a major delicacy among the Apoi which led to great demand for its meat, and there are several canteens where otter meat was served. Many of the interviewees reported catchingt otters accidentally in fishing nets and with spears. In the same vein, another interviewee reported that noise pollution was a threat to otter survival in the area. In Igbotu, all the people interviewed reported that excessive hunting and accidental capture are threat to otters in the area.

Irele Local Government Area

Most of the interviewees confirmed that spotted-necked otters had been killed in the Akotogbo River with special traps, nets, hook and guns. In Ode-Iju Osun, the interviewees confirmed that spotted-necked otter had been killed frequently with wire traps. An interviewee confirmed that he killed 3 otters in the last four months in 2021. They also reported that noise pollution and habitat degradation pose serious threat to its conservation.

Okitipupa Local Government Area

In Araromi Ayeka, otters were reported to have been killed in Igbinsin-Oloto and in Erinje, Spotted-necked otters have also been killed by farmers and fishermen with guns and wire traps (Fig. 6).

Figure 6. A wire trap observed at Igbotu. Source: Field survey, 2021.

Use of Spotted-Necked Otter in Local Communities

The results revealed that all the interviewees affirmed that Spotted-necked otter serves as food (Fig. 7) and a source of income (Fig. 8). The interviewees stated that various parts of the spotted-necked otter are used for traditional medicine in the selected communities across the four local government regions (Tables 4 and 5).

Table 4. Various uses of Otter in the Riverine Areas of Ondo State.

Body Parts	Application	Sociocultural Belief
Head	Head mixed with other ingredients.	For detecting crime and for predicting future occurrence. Antidote against bad luck
Meat	Source of animal protein and income	Increased strength
Skulls and lower jaw bones	Rheumatism, aches	Pain relief Increased strength
Male sex organ	Impotence	Increased virility in men
Bones	Bone, various concoctions	Increased strength in new born babies
Intestines	Pains, Weakness	Increased strength
Claws	Claw decoction with other ingredients	Increased strength and stamina especially when fighting.
Internal organs (liver, bile etc)	Aches, itching, diseases, discomfort, Anaemia	Pain relief and treatment of several diseases
Oil		For production of chemicals

Source: Field survey, 2021

Table 5. Uses of Otter in the Local Government Areas of Ondo State.

L.G.A	Uses					
	Meat	Income generation	Aphrodisiac	Bone/Claw/Skull (Medicinal)	Oil (Medicinal)	Liver/Bile (Medicinal)
Ilaje	100%	95%	80%	92%	60%	95%
Ese-Odo	100%	80%	100%	98%	74%	80%
Irele	85%	55%	60	40%	54%	60%
Okitipupa	92%	64%	20	58%	45%	62%

Source: Field survey, 2021

Figure 7. Roasted head of otter for sale at Igbekebo. Source: Field Survey, 2021.

Figure 8. Head of otter preserved to be sold to traders from Benin Republic.
Source: Field Survey, 2021.

DISCUSSION

Otter Distribution Pattern

The findings reveal that spotted-necked otters are well distributed in all the riverine communities of the four local government areas, and are seen mostly in the morning and evening, especially during the rainy season. This is thought to be due to the abundant of fish species present. They inhabit marshy areas, swamps, and streams of the freshwater ecosystems.This agrees with Kruuk, 2006, who states that spotted-necked otters inhabit only fresh water environments. Perrin and Carranza (2000) reported that Spotted-necked otters use riverine vegetation and rocky riverbanks during the winter dry season, and generally occur where human disturbance is least.

Threats to Otters

It is evident from this study that direct hunting, accidental capture, and noise pollution are the major threats facing Spotted-necked otters in the study area. This is consistent with Acharya (2017): in Nepal, otter populations have declined largely because of degradation of natural habitats and hunting. Ponsonby (2018) reported that expansion of human settlements poses a threat and disturbance to otters, while Trivedi and Joshi (2018) stated that otters are not habituated to human presence.

Uses of Otters

Spotted-necked otters are primarily taken for consumptive purposes in all the communities visited. Spotted-necked otters serve therapeutic purposes which include the treatment of erectile dysfunction in men. This is consistent with findings of Dong et al., (2010), who reported that in Cambodia, an otter's baculum (penis bone), crushed and mixed with coconut milk, is prescribed as an aphrodisiac. De Luca and Mpunga (2013) also reported on several traditional uses of otters and found that they were eaten in southern Tanzania. In addition, the heads of otters are mixed with other plant parts for making an antidote against bad luck among the Ijaws in the Ese Odo local government area. This agrees with Lev (2003), that animals and products derived from different organs of their bodies have constituted part of medicinal substances used in various cultures since ancient times. Rowe-Rowe (1990) also reported that human hunters kill otters for bushmeat food and for their skins, in part as retribution for their eating fish desired by fishermen. Hadipour et al.(2011) reported that the otter is also hunted for its fur and taxidermy proposes in recent years. Still (2003) reported that the demand created by traditional medicine is one of the causes of the over exploitation of population of numerous animal species.

CONCLUSION

The study revealed that otters inhabit freshwater ecosystems and they are well distributed in different habitats ranging from marshy areas, streams and swamps in the riverine communities of Ondo State. However, excessive hunting, accidental capture as well as noise pollution threaten the survival of this keystone species in its home range. Increasing demand for otter's meat for food and body parts for economic and traditional uses may further reduce the already declining populations of otter in the riverine communities. The research also confirmed the presence of African clawless otter (*Aonyx capensis)* in the area, but the scope of work was limited to spotted-necked otter. Therefore, there is need for more conservation education and provision of alternative livelihoods such as mini-livestock production, crafts making and ecotourism initiatives among the locals. Further research should be conducted to extensively study these species in all the coastal communities of Southwestern Nigeria.

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RESUME

RÉPARTITION, MENACES ET UTILISATION DE LA LOUTRE À COU TACHETÉ (*Hydrictis maculicollis*) DANS LES COMMUNAUTÉS LACUSTRES DE L'ÉTAT D'ONDO, AU NIGERIA

Le but de la recherche est d'évaluer le modèle de répartition, les menaces et l'utilisation de la loutre à cou tacheté *Hydrictis maculicollis* dans les zones fluviales de l'État d'Ondo, au Nigeria. Les observations sur le terrain ont été réalisées en parcourant des transects le long des berges des rivières ainsi qu'en utilisant un hors-bord/canoë sur les plans d'eau. Des Discussions de Groupe (DG) et des Entretiens avec des Informateurs Clés (EIC) ont été utilisés pour faciliter la recherche. Au total, 51 groupes de pêcheurs/agriculteurs de 17 communautés des territoires de gouvernement local d'Ilaje, Irele, Ese-Odo et Okitipupa ont été interrogés. Des entretiens avec des informateurs clés ont été menés là où les discussions de groupe ne pouvaient pas avoir lieu. Ceux-ci ont été enregistrés en audio, après quoi ils ont été retranscrits et analysés qualitativement par analyse thématique. L'espèce présente une large répartition dans les écosystèmes d'eau douce le long des berges des rivières, des zones marécageuses, des marécages et des cours d'eau, en fonction de la présence de leurs indices dans la région. Au cours de l'enquête, une loutre morte a été trouvée chez un pêcheur à Olopo, environ 12 crânes et plus de 500 filets endommagés par la loutre ont pu être confirmés sur le cours principal de la rivière Oluwa et ses affluents dans les communautés riveraines. Comme menaces majeures sur la loutre, nous avons observé durant l'enquête la chasse directe avec plus de 65 pièges posés, une capture accidentelle ainsi que la pollution sonore par des vedettes rapides de 15 communautés lacustres. La demande croissante de viande de loutre dans les restaurants locaux, le commerce de certaines parties du corps et leur utilisation en médicine traditionnelle dans la région constituent de graves menaces pour les populations de loutres si elles ne sont pas prises en compte.

RESUMEN

PATRÓN DE DISTRIBUCIÓN, AMENAZAS Y USO DE LAS NUTRIAS DE CUELLO MANCHADO (*Hydrictis maculicollis*) EN LAS COMUNIDADES RIBEREÑAS DEL ESTADO DE ONDO, NIGERIA

El objetivo de la investigación es evaluar el patrón de distribución, las amenazas, y el uso de la Nutria de Cuello Manchado *Hydrictis maculicollis* en áreas ribereñas del Estado de Ondo, Nigeria. Las observaciones de campo fueron realizadas caminando transectas a lo largo de las barrancas de los ríos, así como mediante el uso de lancha rápida/canoa en los cuerpos de agua. Se utilizaron discusiones en Focus Groups (FGD) y entrevistas con informantes clave (KII) para facilitar la investigación. Fueron entrevistados un total de 51 grupos de pescadores/agricultores, de 17 comunidades en las áreas de gobiernos locales de Ilaje, Irele, Ese-Odo y Okitipupa. Las entrevistas con informantes clave fueron llevadas a cabo cuando no podían realizarse reuniones con Focus-groups. Fueron grabadas, luego de lo cual fueron transcriptas y analizadas cualitativamente utilizando análisis temático. La nutria de cuello manchado mostró una amplia distribución en los ecosistemas de agua dulce a lo largo de las barrancas de ríos, áreas pantanosas, pantanos, y arroyos, en base a la presencia de sus índices en el área. Durante el relevamiento, se observó 1 nutria muerta (de un pescador) en Olopo, alrededor de 12 cráneos y más de 500 redes dañadas por nutrias fueron confirmadas en el río principal (Río Oluwa) y sus tributarios. Se observó caza directa con más de 65 trampas puestas en el terreno, y captura accidental así como contaminación sonora por lanchas rápidas, en 15 comunidades ribereñas, como las principales amenazas a la nutria. La creciente demanda por carne de nutria en los restaurantes locales, el comercio en partes corporales, y el uso para la medicina tradicional en la región son serias amenazas a las poblaciones de nutria si no son encaradas.

O B S E R V A T I O N

AN UPDATE ON ASIAN SMALL-CLAWED OTTERS (*Aonyx cinereus*) FROM NAMDAPHA TIGER RESERVE, ARUNACHAL PRADESH, INDIA

Rohan K. MENZIES[1,2]

[1]*Nature Conservation Foundation, 1311, "Amritha", 12th Main, Vijayanagar 1st Stage, Mysore 570017, Karnataka, India.*
[2]*Manipal Academy of Higher Education, Manipal 576104, Karnataka, India*
Email rohanmenzies@ncf-india.org

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Abstract: The Asian Small-clawed Otter (*Aonyx cinereus*) is widespread across Southeast Asia but is experiencing a steady decline in numbers and a reduction in its range. This species is often not studied or even recorded from northeast India and therefore very little is known about it. This note builds on a recent publication on the feeding behaviour of Asian Small-clawed Otters from Namdapha Tiger Reserve in India.
Citation: **Menzies, R.K. (2023).** An Update on Asian Small-Clawed Otters (*Aonyx cinereus*) From Namdapha Tiger Reserve, Arunachal Pradesh, India. *IUCN Otter Spec. Group Bull*. **40** (4): 225 - 229
Keywords: *Aonyx cinereus*, Asian Small-clawed Otter, Arunachal Pradesh, feeding behaviour, India

Bida (2023) described two sightings of the Asian Small-clawed Otter (*Aonyx cinereus*) from two different locations in the Namdapha Tiger Reserve from March 2020 and March 2021, respectively, which included details on foraging and prey species. From this protected area, where otters appear to be the only small carnivores specifically targeted by hunters (Naniwadekar et al., 2013), descriptions of otters could help inform conservation not simply by their occurrences but also by better understanding their ecology. Here, I briefly report an encounter with Asian Small-clawed Otters which corroborate the note by Bida (2023) along with additional observations on their foraging strategies.

On 23 February 2023 at approximately 0900h, while surveying for river birds, a group of four otters were seen on the Namdapha River (27°30'48.16''N, 96°30'43.17''E; 483 mASL), in the Namdapha Tiger Reserve. The otters were seen moving down the river in fairly rapid waters from about 50m ahead of me. They were vocalising with one another as they swam down the river with high-pitched squeaks. The otters would keep stopping by perching on rocks in the middle of the river or on the boulders along the riverbank. They moved swiftly while in the water but also explored the rocks on the banks very quickly perhaps searching for food. One individual was seen on one rock in the river, it dived into the water, caught a fish, re-emerged on another rock with the fish in its mouth, and continued to eat it on a second rock (Fig. 1). A second individual tried to climb on the rock while the first ate the fish; however, it turned its back on the one in the water, refusing to share its catch as reported by Bida (2023).

Figure 1. An Asian Small-clawed Otter (*Aonyx cinereus*) with a fish in its mouth making its way to an exposed rock in the water then observed turning away a second otter and consuming the fish alone.

The size of the fish caught appeared much smaller than the previous report and the fish species was not identified here. Two individuals in particular were scouring the banks but I did not observe them catch or consume anything (Fig. 2). It is possible that the two otters seen along the banks were younger than the two in the water; perhaps not as confident about fishing or foraging in the deeper rapids. The two individuals close to the bank would search under and between the boulders, occasionally dipping themselves in the shallow waters as well (Fig. 2). They appeared to be foraging more in tandem than the two in the water. One is even seen swimming farther downstream when the ones in the river began to move but still staying close to the bank (Fig. 2).

All four otters were feeding, swimming, and communicating for the duration of the sighting which lasted approximately 10 minutes. They were able to rest on even the smallest exposed rocks in the water or would stop at a shallow point, when possible, mostly submerged, before continuing their swim in the rapids (Fig. 3). They continued to swim downstream while continually stopping on rocks from the point of observation until they were not visible any longer.

Figure 2. Two Asian Small-clawed Otters (*Aonyx cinereus*) seen foraging in and amongst the boulders on the banks of the Namdapha River, Arunachal Pradesh, India – eventually swimming downstream and joining the other two otters.

Figure 3. Two Asian Small-clawed Otters (*Aonyx cinereus*) seen on the rocks (exposed and submerged) between dives for fish and to rest after swimming in the rapids.

The diet of Asian Small-clawed Otters has been found to predominantly comprise of crabs and other invertebrates, and is only supplemented by fish (Hussain et al., 2011). The preferred habitat of the species is also reported as narrow, fast-flowing mountain streams less than 5m in width (Hussain et al., 2011); however, in this instance the width was between 20-25m and the otters were able to swim and fish in fast-moving waters. The otters on the banks were possibly searching for crabs with no success and therefore had to fish. This observation of the otters' dependence on the large boulders and riverbanks to forage highlight the need to preserve these habitats as well. There is intensive sand and boulder mining which occur across the region; however, none was observed in Namdapha Tiger Reserve. Another threat to the Asian Small-clawed Otter diet in the Western Ghats in India is the use of destructive fishing such as dynamite and electrofishing (Duplaix and Savage, 2021) which has now been observed in the Namdapha region as well. After surveying approximately 30km of river in Namdapha Tiger Reserve for river birds, this was the only sighting of otters. The suitable habitat available for otters is plenty, with the larger rivers including several smaller streams; however, the threats of hunting and destructive fishing methods might be contributing to the low occurrences. This record is approximately 7.5km downstream of the record by Bida (2023) and closer to the section of river with human presence and therefore greater disturbance. It is perhaps a promising sign that Asian Small-clawed Otters are reported from the Namdapha River, from the two seen in 2021 and now four in 2023, where there exist several threats to otters. There have been very few records from the area (Naniwadekar et al., 2013; GBIF.org 2023) with no systematic surveys in recent years. More focused research on the population of Asian Small-clawed Otters in the area is required and additional aspects pertaining to the species diet and prey availability will also be beneficial to its conservation.

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RESUME

UNE MISE À JOUR SUR LES LOUTRES CENDREES (*Aonyx cinereus*) DE LA RÉSERVE DE TIGRES DE NAMDAPHA, ARUNACHAL PRADESH, EN INDE

La loutre cendrée (*Aonyx cinereus*) est répandue dans toute l'Asie du Sud-Est, mais connaît un déclin constant du nombre d'individus et une réduction de son aire de répartition. Cette espèce n'est pas souvent étudiée ni même observée dans le nord-est de l'Inde et on en sait donc très peu sur elle. Cette note s'appuie sur une publication récente sur le comportement alimentaire des loutres cendrées de la réserve de Tigres de Namdapha en Inde.

RESUMEN

ACTUALIZACIÓN SOBRE LA NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA (*Aonys cinereus*) DE LA RESERVA DE TIGRES NAMDAPHA, ARUNACHAL PRADESH, INDIA

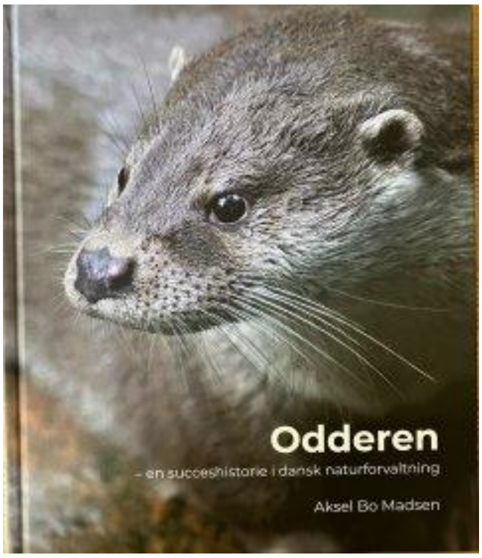
La Nutria de Uñas Pequeñas Asiática (*Aonyx cinereus*) -Vulnerable-, está ampliamente distribuida por el Sudeste de Asia, pero está experimentando una declinación constante en números y una reducción en su área de distribución. Ésta especie es a menudo no estudiada o ni siquiera registrada en el noreste de la India, y por lo tanto se sabe muy poco acerca de la misma. Ésta nota se basa en una reciente publicación sobre el comportamiento de alimentación de las Nutrias de Uñas Pequeñas Asiáticas de la Reserva de Tigres Namdapha en la India.

NEW BOOK

ODDEREN– EN SUCCESHISTORIE I DANSK NATURFORVALTNING

Aksel Bo Madsen

In the last two years I have been retired from Aarhus University and used time to collect the "good story" about the otter in Denmark.



Publisher: The Otter is a book about an administrative success. From being threatened with extinction in the early 1980s, the otter in Denmark is now again on the rise over most of the country. Aksel Bo Madsen has researched and communicated about otters since 1984 and with his research has been behind the advice for the administration about the otter. The book tells both about the otter's biology and how, in terms of legislation and communication, you can help a population get back on its feet.

Contents:

Odderen i Danmark
Projekt Odder
Formidling
Forskning
Forvaltning
Alverdens Oddere
Den Euroasiatoske odder og Fremtiden

Citation: Madsen,A.B. (2023). Odderen – en succeshistorie i dansk naturforvaltning. Naturforlaget, Egå