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

NOTE FROM THE EDITOR

Dear Friends, Colleagues and Otter Enthusiasts!

I am writing this editorial note in a very special situation. Many of us work from home due to the current pandemic. I hope that you and your families and friends are all fine and that you find good ways to organise your daily life and your work. As we are all engaged in wildlife many of the lessons to be learned from the current situation are not really a surprise for us. I do hope that we may find your ways and channels to inform the general public on important steps to be taken in the future to protect wildlife and the human society we all live in.

The current situation also should allow us all to step a bit back, lower our shoulders and see what is really important for us. All the restrictions also give some time to reconsider our way of living, the use of resources and the related carbon footprint.

As always I want to express my sincere thanks to Lesley. Despite all the extra work that the current situation caused to all of us Lesley managed to publish the last issue very fast and we can already start issue two of this year. Thank you so much for all your efforts and patience with me and authors.

OBITUARY

Dr. Motokazu Ando
27th March 1950 – 24th March 2020
by Hiroshi Sasaki

Dr. Ando was born in Osaka on March 27, 1950, and passed away from pancreatic cancer on March 24, 2020 at the age of 69.

After graduating from the Department of Science, College of Liberal Arts, International Christian University in 1973, he joined Hani Productions and was involved in filming wildlife movies in Africa, etc. After that, he became a temporary staffer at the Zoology laboratory of Professor Hideo Obara in the Women's Nutrition University. His otter life might be said to have started with joining the survey of Japanese otters by Yoshiharu Imaizumi in Kochi Prefecture from 1972 to 1976. In 1978, he entered the Graduate School of Agriculture, Kyushu University, to study wildlife. In 1982, he became a lecturer at the Department of Biology at Gyeongnam University in South Korea while he was a graduate student, and started otter research in South Korea, which until then had hardly been studied. After obtaining his Ph.D. in 1985 for research on arboreal and gliding adaptation of the giant flying squirrel (*Petaurista leucogenys*), he started to work as an officer of Shiga Prefecture. In 1993 he joined the staff of the International Lake Environment Committee Secretariat for the conservation of wetlands and later was a consultant for global wetland conservation. In 2001, he got a job at Tokyo University of Agriculture, where he studied the ecology of many mammals including otters, with many students. He retired in 2015, moved to Yamazaki Gakuen University, retired again in 2018, and became an emeritus professor at Yamazaki Animal Nursing University.

In 1989, I was asked by the government to study the present situation of otters in Kochi Prefecture, but I had never done an otter survey. I asked Dr. Ando to teach me how he studies otters in Korea. Dr. Ando and I established the Otter Research Group, and had carried out much research and awareness-raising activities for otters in various parts of Asia, such as the Korea-Japan Otter Symposium in Japan and South Korea in 1995, IUCN OSG Asia Group meeting in Thailand in 1996, Workshop on surveying and monitoring otter populations in Thailand in 1997, Workshop on conservation and public awareness of otters in Taiwan in 1999, Workshop on otter conservation in Toa Daeng Peat Swamp Forest in 2000, the Pan-Asian otter workshop in India in 2002, andWorkshop on Enhancement of Knowledge and conservation otters in U Minh Thuong National Park in Vietnam in 2002. We published The Wetlands Ambassador-Education and Public Awareness methodologies for otter conservation in English in 2001 and in Korean in 2002. During this time, he also joined the OSG..

For wetland conservation, he has been the Chairperson of Japan at Ramsar Center from 2006 to 2018, and was also active as Vice Chairman of the Japan Wetland Society from 2013 to 2018. He has been active as a board member of the Wildlife Conservation Research Group since 2006, has taken the leadership as a chairperson from 2013 until his death, and also as a member of this group delegation for the CITES meeting.

Dr. Sung-yong Han, who has conducted otter surveys in South Korea with him, founded the Korean otter research center in 2013. His major achievement about otters was the publication of the Japanese Otter: Lesson from its Extinction in 2008.

What I was always impressed with was that Dr. Ando persisted to publish graduation thesis, records of attending an academic conference and so on. In addition, Dr. Ando was very energetic. He attended the Asia Wetland symposium in November 2017 just after he had known about his cancer. He also attended the IOC in China in 2019, which was the last one for him. He continued many lectures and visited to foreign countries without stopping research and awareness raising activities. I met him at the meeting of otters in Tsushima in February 2020, and at that time, he said he had prepared his funeral and selected his coffin by himself. He continued to write manuscripts for otters in March. He never stopped working until he died. I promised to visit his house in March to assemble the otter materials together, but I could not meet with him.

The students who were taught by Dr Ando and those who were influenced by his otter book are growing. I still don't feel that Ando-san, who guided me to otter research and international activities, died. The activities of the otter research group, which was created by the two of us, have been passed on to the Japan Asian Otters Conservation Association, which is supported by young people, and the seeds sown by Dr Ando are gradually growing..

A R T I C L E

THE SITUATION OF PET OTTERS IN JAPAN – WARNING BY VETS

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Abstract: Clinical data for 20 pet otters treated at two animal hospitals in Japan was collected from August 2010 to May 2019. Most otters were in a critical condition or already dead when they were brought to the hospital. All otters were identified as Asian small-clawed otters and kept privately at the owner's house or otter café. Nine of the otters were considered to have been imported illegally (No.4-8 and No.13). Regarding the diseases suffered, kidney stones were seen most frequently, then pneumonia and the third was dehydration. Most of the otters looked thin due to inadequate nutrition. An inappropriate environment was the most common cause of diseases in pet otters, followed by inadequate nutrition and then stress. Two otters with stress-related illness were kept in the same otter café, where petting by people unknown to them could have caused their condition. Although laws regarding to Asian small-clawed otters in Japan was changed in August 2019 according to the change of CITES rank from II to I, the monitoring on the domestic otter market should be kept until the situation is improved. In conclusion: firstly, owners should be aware of basic husbandry of Asian small-clawed otters before owning one, and secondly, improvement on management system of captive otters, and enforcement of such regulations is a key factor for more effective otter protection in Japan. From the point of view of animal welfare, the current situation of pet otters in Japan has to be improved as soon as possible to prevent more tragic deaths. We hope that this information can contribute to a better management and protection of otters.

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INTRODUCTION

As many articles report, otters are becoming one of the most popular animals in Japan these days (New York Times, 2019). However, too much popularity is causing many serious problems such as the illegal pet trade, poaching or business use for commercial facilities including otter cafés (McMillan, 2018, Kitade and Naruse, 2018). One of the biggest reasons that Japan has become a hot spot of the otter trade must be because of the high retail price of otters: it has reached over 300 times the reported black market price in Thailand (USD 30 in Thailand compared to USD 9,000 per juvenile or more in Japan) (Kitade and Naruse, 2018).

Usually, the Asian small-clawed otter (*Aonyx cinereus*) is kept as an individual pet or exhibited in otter cafés in Japan. This species was formerly listed on CITES Appendix II before August 2019, and is not protected under the Law for the

Conservation of Endangered Species of Wild Fauna and Flora that regulates domestic trade of animals in Japan (McMillan, 2018). In addition to the unregulated trade, there is no domestic registration system or husbandry guidelines for pet otters in Japan, which makes it much easier to keep this species in captivity than in countries with such systems. To change this situation, the Japanese government declared on August 2019 that the Asian small-clawed otter will be designated as an ”International Endangered Species of Wild Fauna and Flora” under the domestic law and domestic otter trade would have been restricted from November 2019 according to the international decision that the CITES Appendix rank of this species was changed from II to I.

It must be admitted that otters are very attractive animals, and extremely photogenic. In Japan, whilst buying an otter was easy, it is difficult for people to keep one correctly in private properties because otters need a large space, a semi-aquatic environment and a variety of foods, up to 20% of their body weight per day (Heap et al., 2008). In addition, the faeces have a strong smell, and the animal has sharp teeth and powerful jaw muscles, capable of cracking crustacean shells. The Asian small-clawed otter is also highly social, and requires either others of its species in a stable group, or intensive interaction with its owner. In short, it is completely unsuitable for private ownership in urban environments, and require specialized, and expensive conditions on more rural properties.

However, little information on how to keep pet otters correctly, and on the medical conditions they experience is available in Japan, and the demand for pet otters has kept growing through the influence of social media (New York Times, 2019). To reveal the truth and discourage the inappropriate private keeping of otters, a survey on pet otters treated at animal hospitals in Japan was conducted and is presented in this report.

APPROACH

Clinical data on privately owned otters was collected at two animal hospitals in Nagoya and Tokyo, Japan from August 2010 to May 2019. In addition to basic information about the treated otters (age, sex, body weight and disease), the estimated cause of disease and other features have been recorded. However, age is only based on the owner’s information.

RESULTS AND DISCUSSION

In total, 20 cases of pet otter treatment were recorded and most of the otters were in a critical condition or already dead when they were brought to hospital (Table 1). All otters were identified as Asian small-clawed otters and had been kept privately at the owner’s house or at an otter café.

Many serious diseases were observed, such as kidney stones (Figure 1), dehydration and pneumonia (Figure 2), bite injuries (Figure 3), dental problems (Figure 4) and alopecia (Figure 5). In decreasing order of frequency, kidney stones were observed most often, then pneumonia, and third was dehydration (Figure 6). Most otters looked skinny and one 4-month old otter (No. 14) was especially emaciated, weighted only 450g. Based on studbook database, this is almost the same body weight as a 50-day old otter. In addition to that, there was no food left in the stomachs of two dead otters (No. 2 and 3), and the gallbladder of No. 3 was even enlarged due to chronic hunger. The average age at death of these otters was only 1 year and 7 months, which is much shorter than the normal 10-15 year life span in captivity (Perdue et al., 2013).

Table 1. Data on otters treated at two animal hospitals in Japan from August 2010 to May 2019.

No.	Species	Age	Sex	BW (kg)	Disease	Kept place / Import	Dead / Died
1	ASCO	6 yrs	F	2.34	Kidney stone	House	Died in 18 days
2	ASCO	3 yrs 6 mths	M	2.8	Hypothermia	House	Dead when found
3	ASCO	2 yrs 4 mths	F	3.08	Asphyxiation	House	Dead when found
4	ASCO	1 mths	F	0.2	Dehydration, Pneumonia	Import	Died in 2 days
5	ASCO	1 mths	F	0.25	Dehydration, Pneumonia	Import	Died in 3 days
6	ASCO	1 mths	M	0.35	Dehydration, Pneumonia	Import	Died in 5 days
7	ASCO	1-2 mths	F	0.55	Dehydration, Pneumonia	Import	Died in 14 days
8	ASCO	2-3 mths	M	0.95	Dehydration, Pneumonia	Import	Died in 30 days
9	ASCO	3 yrs	M	3	Kidney stone	House	Dead when found
10	ASCO	4 yrs	F	3.5	Kidney stone	House	Dead when found
11	ASCO	4 yrs	F	2.8	Kidney stone	House	Dead when found
12	ASCO	1 yrs 9 mths	F	2.3	Bitten injury, Ulcer	House	-
13	ASCO	4 mths	M	0.45	Pneumonia, Renal insufficiency	Import	-
14	ASCO	8 mths	M	2.2	Bitten injury, Ulcer	House	-
15	ASCO	2 yrs	F	2.3	Self bitten injury, Kidney stone	House	-
16	ASCO	2 yrs	M	3.2	Kidney stone	Otter Café	-
17	ASCO	1 yrs 8 mths	F	3	Alopecia, Kidney stone	Otter Café	-
18	ASCO	3 mths	F	1.4	Asphyxiation, Cerebellar dysfunction	Otter Café	-
19	ASCO	2 yrs 2 mths	M	4	Kidney stone	Office	-
20	ASCO	6 mths	F	1.95	Hematochezia, Kidney stone	Office	-

Figure 1. A female otter (No.1) which was fed only cat foods and human biscuits, died due to renal failure probably because of the high salt level in its diet. On the x-ray quite a lot kidney stones could be seen.

Figure 2. An otter cub (No. 4) which died because of dehydration and pneumonia, which occurred during importation.

Figure 3. A female otter (No. 12) seriously injured due to a bite by a male otter companion.

Figure 4. A male otter (No. 16) kept in the otter café had serious dental problems, including clear evidence of caries.

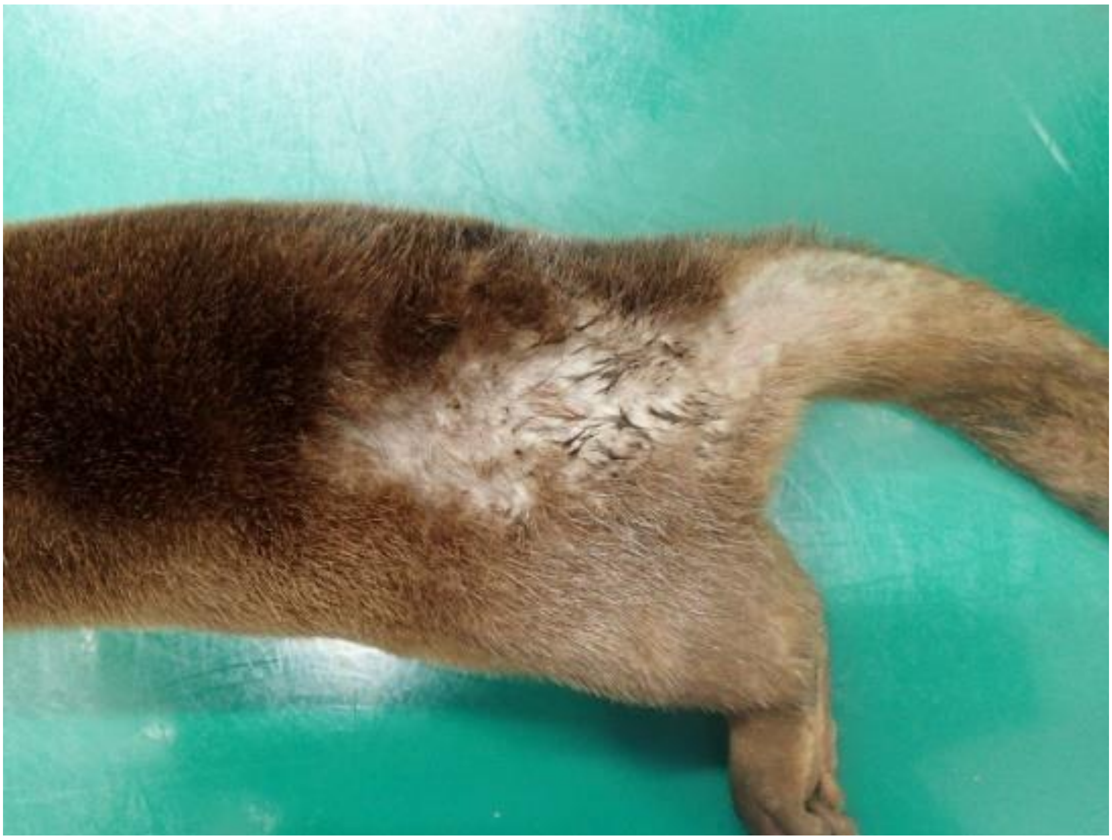

Figure 5. A female otter (No. 17) had alopecia which might have occurred directly because of the stress of petting by strangers at the otter café, but can also be caused by malnutrition.

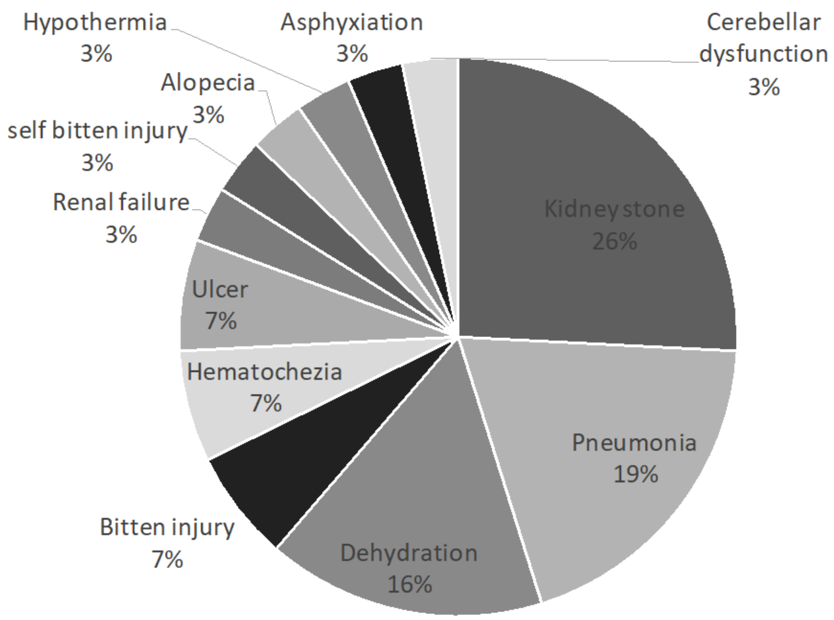

Figure 6. Diseases of treated or dead otters observed during this survey.

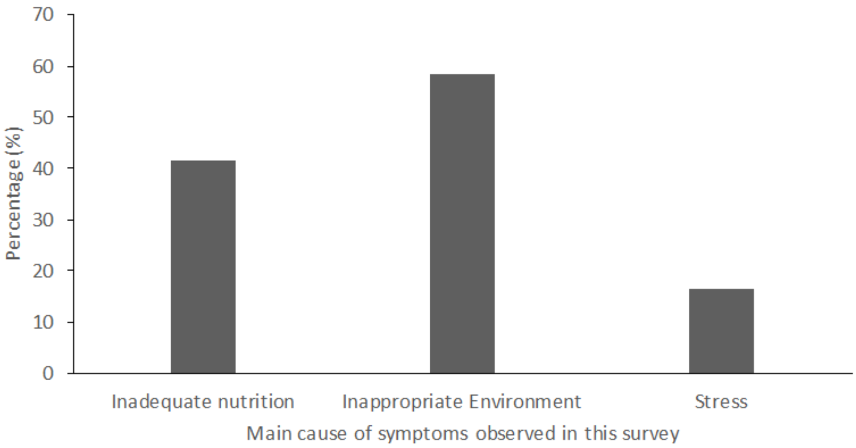

Figure 7. Main causes of diseases and injuries in otters observed during this survey.

In terms of the causes of these diseases, an inappropriate captive environment, such as low temperatures, no access to water for exercise, or incompatible breeding partner were the most frequent causes (58%). Secondly, many diseases such as kidney stones and hematochezia (blood in stool) occurred due to inadequate nutrition. Especially, from the 20 animals, 5 have been cubs under 3 months of age. It is questionable if these cubs got an adequate milk replacement because they still would have needed normally their lactating mothers. Weaning time in this species is with around 80 days / 3 months. But also in older otters, some owners even simply did not give large enough amounts of food to their otters. Sometimes on purpose, to make otters have less strong-smelled faeces. Thirdly, symptoms of mental problems were also observed, for example; the self-mutilation injury and alopecia. Two otters with these stress-related symptoms were all kept in the same otter café and it is believed by the veterinarian that petting by unknown people for long hours caused huge stress for the animals.

The Asian small-clawed otter normally lives 10-15 years and up to 20 years in captivity (Perdue et al., 2013). However, the average age of otters at death observed in this study was only 1 year and 7 months, which is very short- they have barely achieved maturity. To determine exactly how inappropriate feeding affected the otters in this study is difficult, because it is known that Asian small-clawed otters often develop kidney stones (urolithiasis/nephrolithiasis) in captivity even under good husbandry conditions and even in young age (Petrini et al., 1999, Bochmann et al., 2017). However, while wild otters forage for a wide variety of food~~s~~ items including fish, crustaceans, crabs, snails, mollusks, frogs or small birds (Heap et al., 2008), these pet otters were normally only fed on cat food~~s~~ or human food~~s~~ with high salt content. It is recommended to feed otters in captivity a diet similar (around 60%) to their wild one and avoid food~~s~~ containing red meat proteins and salt in high concentration as in cat food~~s~~, dog biscuits and kibbles (Jason Palmer, pers. comm). Hence, it is estimated that the wrong feeding have caused serious nutritional problems in these otters.

Otters and the Law in Japan

Law enforcement is very important as an effective tool to protect wildlife. Japanese laws regarding to Asian small-clawed otters are listed here.

Import; in Japan, the international wildlife trade is normally regulated by the Foreign Exchange and Foreign Trade Act and Customs Law. Under these laws, people currently cannot import the Asian small-clawed otters from the wild except with academic purpose or individuals bred in captivity or got properly before August 2019. Among the 20 cases observed in this study, nine otters were thought to have been imported illegally because their owners faced criminally charges later (No. 4-8 and No. 13).

Domestic trade**;** As mentioned above, domestic trade of CITES Appendix I species is tightly controlled under the Law for the Conservation of Endangered Species of Wild Fauna and Flora. Because of the CITES rank upgrade from II to I of the Asian small-clawed otter and this species was designated as an "International Endangered Species of Wild Fauna and Flora" under this domestic law on August 2019. The domestic otter trade would have been restricted and people have to obtain the registration form when trading from November 2019. However, the trade is still possible under this situation; 1) individuals born under parents with registration 2) individuals obtained in the domestic market before the law regulation changes 3) individuals imported under the permission of Customs Law.

Private keeping**;** all pet animals including otters should be kept well with a suitable environment under the Act on Welfare and Management of Animals. Also, people have to register the pet otter on CITES I under the Law for the Conservation of Endangered Species of Wild Fauna and Flora from November 2019. Although it seems to be the best solution to control the pet otter market, however, there is another risk that all otters in Japan including poached individuals will be registered as proper imported or captive bred individuals.

For the better captive management and prevention of tragedies occurring with pet otters in this country, the monitoring should be kept even after the laws on otters in Japan were improved in 2019.

CONCLUSIONS

While the critical threat to the illegal otter, and the increasing commercial use of otters in cafés in Japan have been becoming clear in recent years, the actual welfare state of the owned otters was almost unknown due to the lack of a registration or monitoring system by the government. In this paper, we reveal the first sight of the inappropriate management and poor welfare state of privately kept pet otters in Japan.

RECOMMENDATIONS

Firstly, information about basic husbandry of Asian small-clawed otters should be prepared and disseminated to would-be owners so that they can have easily access to these information before they buy a pet otter. Probably husbandry guidelines, which exist already in other countries, could be translated and set on otter pages in the internet so that they would be available for everyone who is interested. However, it should be recommended sharply, otters not to use as pets in normal households or as petting animals. The survey showed that many otters are, through ignorance of their needs, kept in poor environments with inadequate nutrition, causing the tragic deaths of many animals. The information collected in just two animal hospitals is the tip of the iceberg and further investigation is necessary. Especially the findings of very young animals (1-2 months old) show, that there is absolutely no knowledge about nutrition, because juveniles in this age are still dependent on their mothers. They will be nursed at least until 80 days. So as recently as an age of nearly 3 month they start to eat solid food.

Secondly, the enforcement of management system on captive otters is a key factor for the more effective protection of otters in Japan. Although registration on captive otters will be started from November 2019 according to the changes of domestic laws, however, there is another risk that all otters in Japan including poached individuals can be registered as proper imported or captive bred individuals. To prevent this situation, the application for registration should be strictly examined by the Japanese government. Also, inspection of the captive environment and husbandry regime for a proposed pet otter could prevent the casual acquisition of an animal with complex needs, and lead to a decline in popularity of otter keeping and the demand for them as pets. Regarding to the international otter trade, it is still concerned that otters could be imported under the CITES regulation exception that; Article VII of CITES states that species listed in Appendix I that are bred in captivity for commercial purposes are treated as Appendix II. In addition to otters, many other exotic species are currently kept privately as pets (McMillan, 2018), so the whole legal system regarding to wildlife keeping should therefore be reconsidered and the monitoring should be kept on the international and domestic otter trade until the situation is completely improved.

From the point of view of animal welfare, the current situation of pet otters has to be improved as soon as possible to prevent more tragic deaths. We hope that the information we present here can contribute for better management and protection of otters.

Acknowledgement - We wish to thank all the people who cooperated with us, and Kaori Fujita and Sakura who gave us professional veterinary advices. We also would like to show our appreciation to Jan Reed-Smith, Meredith Knott and Sarah Duncan who shared otter information for this study.

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RESUME

LA SITUATION DES LOUTRES, COMME ANIMAL DE COMPAGNIE, AU JAPON – UNE MISE EN GARDE DES VÉTÉRINAIRES

Des données cliniques concernant 20 loutres, animaux de compagnie, soignées dans deux hôpitaux vétérinaires au Japon ont été recueillies d'août 2010 et mai 2019. La plupart des loutres étaient dans un état critique ou étaient déjà mortes lorsqu'elles ont été transférées à l'hôpital. Toutes les loutres ont été identifiées comme étant des loutres cendrées gardées par un propriétaire privé ou dans un « Café à loutres ». Neuf de ces loutres ont été considérées comme importées illégalement (n ° 4 à 8 et n ° 13). En ce qui concerne les maladies dont elles souffrent : les calculs rénaux sont les plus fréquents, vient ensuite la pneumonie et en troisième lieu la déshydratation. La plupart des loutres semblaient maigres de par une nutrition inadaptée. La cause la plus fréquente des maladies chez les loutres de compagnie était liée à un environnement inapproprié, suivi d'une nutrition inadaptée et ensuite le stress. Deux loutres souffrant de maladie liée au stress ont été placées dans le même «Café à loutres», où des caresses de personnes inconnues auraient pu être la cause de leur stress. Bien que les lois concernant les loutres asiatiques au Japon aient été modifiées en août 2019 en fonction du passage de l'annexe II à l'annexe I de la CITES, la surveillance du commerce de la loutre comme animal de compagnie sur le marché intérieur devrait être maintenue jusqu'à ce que la situation se soit améliorée. En conclusion : premièrement, les propriétaires doivent être informés des règles de base de l'élevage des loutres cendrées avant d'en acquérir une, et deuxièmement, l'amélioration du système de gestion des loutres captives et un renforcement de la régulation sont un facteur clé pour une protection plus efficace des loutres au Japon. Au point de vue du bien-être des animaux, la situation actuelle des loutres au Japon, comme animal de compagnie, doit être améliorée dès que possible pour éviter des mortalités plus tragiques. Nous espérons que ces informations pourront contribuer à une meilleure gestion et protection des loutres.

RESUMEN

LA SITUACIÓN DE LAS NUTRIAS COMO MASCOTAS EN JAPÓN – UNA ADVERTENCIA DE LOS VETERINARIOS

Colectamos datos clínicos de 20 nutrias-mascotas en dos hospitales animales en Japón, de Agosto 2010 a Mayo 2019. La mayoría de las nutrias estaban en condición crítica o ya muertas cuando fueron ingresadas al hospital. Todas las nutrias fueron identificadas como Nutrias Asiáticas de Uñas Pequeñas, y mantenidas en cautiverio en forma privada en una casa o en un "café de nutrias". Nueve de las nutrias se supone que fueron importadas ilegalmente (No. 4-8 y No. 13). En cuanto a las enfermedades, lo más frecuente que vimos fueron piedras en los riñones, luego neumonía, y la tercera deshidratación. La mayoría de las nutrias estaban muy flacas, debido a nutrición inadecuada. La causa más común de las enfermedades en nutrias-mascotas fue su ambiente inadecuado, seguido por nutrición inadecuada y luego stress. Dos nutrias con enfermedad relacionada con el stress estaban en el mismo café de nutrias, y las caricias por gente desconocida podría haber causado su condición. Aunque en Agosto de 2019 fue modificada la legislación relacionada con las nutrias asiáticas de uñas pequeñas (pasaron del Apéndice II de CITES al I), el monitoreo del mercado de nutrias domésticas debería ser mantenido hasta que mejore la situación. En conclusión: en primer lugar, los dueños deberían tener conocimientos en cuidados básicos de nutrias asiáticas de uñas pequeñas antes de tener una, y en segundo lugar, el mejoramiento en el sistema de manejo de nutrias en cautiverio, y la fiscalización de esas regulaciones, es un actor clave para la protección más efectiva de las nutrias en Japón. Desde el punto de vista del bienestar animal, la actual situación de las nutrias-mascotas en Japón tiene que mejorar lo más pronto posible para prevenir más muertes trágicas. Esperamos que esta información pueda contribuir a un mejor manejo y protección de las nutrias.

ARTICLE

AN ASSESSMENT OF HUMAN ATTITUDES TOWARDS OTTERS IN MBINGA DISTRICT, TANZANIA

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Abstract: A questionnaire survey was conducted among rural residents of the Mbinga district of southern Tanzania. Two hundred and fifty people, between ages 15 and 84 were interviewed, comprising farmers, farmer/fishermen, fishermen, and others. Information was collected on respondents' awareness of the two otter species (*Aonyx capensis* and *Hydrictis maculicollis*), their likes and dislikes of otters, damage to equipment, netted fish, fish in ponds, perceived impact on fish populations, traditional lore, and what uses are made of otters. Opinions on the future conservation and management of otters were elicited. All responses were correlated with the tribal affiliation, occupations, sex and ages of respondents. Findings will be used to better understand the local inhabitants' opinions and attitudes regarding otters and guide the creation of freshwater conservation outreach materials to address the needs of people and wildlife. The development of this future program will emphasize the need to empathize with human economic requirements and perceptions when creating an acceptable and workable plan to benefit the conservation of otters and their environment.

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Keywords: otter, traditional medicine, Tanzania, local opinion

INTRODUCTION

Information gathering on, and the conservation of small carnivores in Africa is beset with many issues; such as incomplete knowledge of behaviour, lack of community awareness or traditional bias against these species as well as frequent conflict with human neighbours. At this time, the spotted-necked otter (*Hydrictis maculicollis*) and African clawless otter (*Aonyx capensis*) are believed to occur throughout much of their former ranges but reliable status/presence information is dated for much of that area and, where populations are confirmed, the numbers are declining (Jacques et al., 2015; Reed-Smith et al.,2015).

In 2017 the African Otter Network (AON) began working with local citizen conservationists to develop a network of local otter champions. The first project was conducted in southern Tanzania where conflicts between fishermen, pond owners, and the otters had been reported. The purpose of this project was to: 1) Determine local communities' knowledge of and attitudes towards otters, 2) Establish presence of otters and identify which species, and 3) Train a local leader for future otter conservation work. Results from the formal survey (250 participants) have yielded information on the awareness and perception of otters as well as traditional uses of otters. The responses to the informal presentations conducted appear to indicate a positive impact as the result of having a local citizen activist involved.

STUDY AREA

Mbinga District (2002 population 404,799), Ruvuma Region of southern Tanzania. In the early 2000s there were 181 registered villages and an uncounted number of fishing centres or small camps. The district incorporates a large shoreline section of Lake Nyasa (Lake Malawi) which constitutes a majority of the area (~26% in total) covered by water. Another ~22% of the region is forest with the remaining ~52% considered arable land. Within these arable areas and forests are many small streams with wetland areas which combined with the lake shoreline offer suitable habitat for both otter species.

METHODS

Twenty-four questions (Appendix A) were asked of 250 respondents; as far as possible different age classes were included but owing to the nature of the targeted area, respondent occupations are dominated by farmers, fishermen/farmers (respondent identified as involved in both occupations), and fishermen (Fig. 2, 3). If a participant did not want to answer a question or had no answer it was left blank. All interviews were conducted in Swahili by the primary author between October 2017 and November 2018. For species identification purposes photographs of both species of otter and the marsh mongoose (*Atilax paludinosis*) were shown and individuals asked to identify the species they know and name them. Photographs were of wild individuals taken in Tanzania; none of the animals were shown eating and all where on land so the entire animal could be seen. Positive responses were scored when the individual correctly identified the animal and gave the local name known to the primary author. Additionally, several school presentations (Fig. 4) and informal meetings were conducted which presented basic information on otter behaviour and the role they play in healthy ecosystems. The project was focused on the area around Mbinga town, the shores of Lake Nyasa, and communities located near the northern edge of Liparamba Game Reserve. GPS locations of all presentations and interview sites were recorded.

Figure 1. Talking with fish pond owners (Photo: W. Mgomo)

Figure 2. Fisherman showing his net (Photo: W. Mgomo)

Responses were evaluated based on tribal affiliation, occupation, and age groups. The latter were arbitrarily grouped to reflect school age as well as early, middle, and later work careers and exposure to traditional stories or cultural influences. Occupation categories were collapsed into farmer, fisherman, fishermen/farmers, pond owners (Fig. 1), students, other, and fish sellers to evaluate the influence of profession on attitude towards otters and knowledge of traditional uses (Appendix B). Although only 54 respondents were female, there responses also were evaluated to determine if there were any significant differences in attitude towards, or knowledge of otters between males and females (Appendix C, Appendix D).

Figure 3. Meeting with Lake Nyasa fishermen (Photo: W. Mgomo)

Figure 4. Talking with school children (Photo: W. Mgomo)

Limitations of methods used

Efforts were made to focus on respondents who had not previously attended informal gatherings with the primary author. However, it is possible that attendance by some influenced answers to questions like; Do you like otter? Should they be conserved, etc. The sample size was not large enough to adequately evaluate any differences between men and women in their attitudes towards otters and questions were not asked of women to clearly sort out the influence of their husband's occupation on their attitudes.

RESULTS

Interviews were conducted in 37 towns or villages and four fishing areas on Lake Nyasa; all respondents reported as being from the Liparamba, Mbinga, or Lake Nyasa areas. School programs reached approximately 2,518 students plus their teachers at one secondary school and seven primary schools located throughout the area. These presentations included educational material developed by the researchers and African Otter Network Education Director on conservation, the value of freshwater ecosystems and the role otters play in these habitats.

Informal discussions and presentations were conducted in all communities visited, including the area around the Liparamba Game Reserve (~90 farmers and park staff), with fishermen along the Lake Nyasa shoreline, pond owners, and two community leader groups. A total of roughly 150 fishermen, 30 fish keepers (pond owners) and 700 farmers or villagers participated in discussions about conservation and the area's otters. These meetings included the use of photos (otters sunning themselves on land taken in Tanzania) to identify the otter species, a short talk about the biology of otters, and a discussion about the participants' familiarity with, and reaction to the otters they encounter. The 250 survey participants were selected from these communities. Most were interviewed prior to meetings but not all. A breakdown of responses based on sex is in Appendix C and along occupational lines for males and female in Appendix D. No significant differences were found, perhaps due to the small female sample size.

Study participants (male = 196, female = 54) ranged in age from 15 to 84 years. They reported as being from ten tribal affiliations (Appendix B) and provided otter names in four local languages. Of the 26 people who mentioned the use of otter skin (most often from the tail specifically) to treat cerebral meningitis in children 16 were from the Matengo tribe and the other 10 were Ngoni; all 26 were farmers and all reported awareness only of the African clawless otter. There were no other correlations with tribe and attitude towards otters or knowledge of traditional uses.

Awareness of Otters

Awareness of otters and which species was correlated somewhat with occupation. Of the 98 farmers interviewed, 65% reported being familiar with the African clawless otter. Of the 41 fishermen interviewed, 78% were familiar only with the spotted-necked otter. Also, out of 62 farmers who also reported spending time fishing (fishermen/farmers) 74% were familiar only with the spotted-necked otter and 21% were familiar with both species. Somewhat interesting was of the 27 people who reported they had a fish pond of some kind 74% were familiar only with the spotted-necked otter and 33% were familiar with both species.

Table 1. Respondent awareness of otter species – based on identification of photos

Occupation of Respondent	African Clawless otter	Spotted- necked otter	Both Species	None
Students = 7	5	1	0	1
Farmers = 98	64 (65%)	14	8	12
Fisherman/farmer = 62	2	46 (74%)	13	1
Pond owners = 27	5	12 (44%)	9	1
Fishermen = 41	1	32 (78%)	8	0
Other = 11	2	7	2	0
Fish seller = 4	1	1	2	0

Do you like Otters?

Farmers – Seventy-two (81%) said they liked them and 21 said they do not like them; 80 said they caused no harm and 15 responded they did cause them harm with one additional citing of only some harm. Of the 21 who responded they did not like otters 11 responded the otters caused no harm to them and two of the respondents who did not know otters replied they caused harm.

Fishermen – Twenty-four (58%) reported they like otters, 16 that they did not like them and one did not know. Thirty-one (76%) reported otters cause significant harm (n = 19), only some damage (n = 12), and 10 replied the otters caused them no harm.

Table 2. Do you like otters?

Occupation of Respondent	Yes	No	Don't know
Students = 7	7	0	0
Farmers = 98	73	21	5
Fisherman/farmer = 62	43	16	3
Pond owners = 27	16	8	3
Fishermen = 41	24	16	1
Other = 11	7	1	3
Fish seller = 4	0	1	3

Table 3. Do they cause you harm (n=250)?

Occupation of Respondent	Yes	Some	No	Don't know
Students = 7	0	0	7	0
Farmers = 98	15	1	80 (82%)	2
Fisherman and farmer = 62	30*	21*	11	0
Pond owners = 27	10	9	8	0
Fishermen = 41	19**	12**	10	1
Other = 11	1	0	10	0
Fish seller = 4	0	1	3	0

* 82% of fishermen/farmers responded otters cause some degree of harm
** 76% of fishermen responded otters cause some degree of harm

Questions 12 – 17 regarding kind of harm, fishing equipment/practice and economic impact

Of the 250 respondents, 152 replied to one or more of the questions regarding the kind of harm caused, how often, fishing equipment used, how long nets are left in the water, how much does it cost, and how much do you earn from fishing or your pond. Of these, nine farmers responded they cause harm by polluting water with their scats, have heard they destroy nets, and/or eat fish. One respondent listed in other category (did not identify as fisherman or pond owner) replied they destroy nets, eat fish, and often cause harm. One farmer replied otters sometimes eat his chickens; one student and three fish sellers had heard of them destroying nets and eating fish. One pond owner knew of them killing a bird. This left 136 who responded to at least four of the six questions which form the basis for the following table (respondents may have mentioned more than one kind of harm).

Table 4. Interviewee Results Regarding Fishing Practices

What kind of harm do they cause you? Damage nets, eat fish, damage fish traps, damage pond?

Net Damage	Eat fish in nets	Eat fish from ponds	None
76	80	17	25

How often do they cause harm?

Never	Seldom	Frequently
28	58	50

What is the cost of the harm?

None	New Fish trap	Buy new net	Repair net	Eat the fish	Buy new fish
40	1	38	72	15	14

What kind of net do you use?

No answer	2 – 3.5cm	4 – 5 cm	6 -7cm
30	**75**	**45**	**7**

How long do you leave your net in the water?

No answer	3 – 6 hours	7 – 11 hours	12 hours	24 hours
30	**3**	**31**	**53**	**19**

How much do you earn from fishing in a day?

The majority (111) responded that the amount they earned varied and did not offer an estimate. Those that did ranged from nothing (pond owners primarily) to roughly $5 - $18 per day. This question did not provide the information we were looking for as it was poorly worded and, possibly the fishermen did not want to share what they earn.

Uses of Otters

Several traditional uses were mentioned. A few individuals reported only hearing of a particular use; however, the majority characterized it as “I/we believe…”, “We use otter for…” or in the case of eating otters all but one reported doing so themselves. As mentioned earlier, use of otters to treat cerebral meningitis in children was associated with respondents from two tribes.

The only tradition that appears to be associated with occupation is belief in the presence of a root in the otter’s mouth. Sixteen of the 37 respondents reporting this were fishermen and 16 were fishermen/farmers. Five were farmers who reported of hearing of this. The two mentions of use in treating constipation were from pond owners; one cited using boiled meat and the other using otter feces. Of the 176 responses from the 151 participants who knew of a traditional use 52 said they are eaten, 37 were of the legend of the otter’s mouth root, and 87 dealt with medicinal or a cultural traditional use.

Table 5. Otter Use by Occupation

Otter uses by occupation			
(Figure given in occupation is number reporting a use; several individuals reported more than one use. The percentage in use category is based on the total number of study participants (*n#)* in each occupation category. * Percentage of total participants in that occupation who reported a consumptive/traditional use of otters.)			
Occupation	**Bush meat**	**Root legend**	**Traditional use**
Farmer = 52 (*n* = 98) *53%	6	2	45 (46%)
Fisherman/farmer = 45 (*n* = 62) * 72%	24 (39%)	17	14
Fisherman = 24 (*n* = 41) *58%	5	16	7
Pond owner = 20 (*n* = 27) * 74%	13 (48%)		14 (52%)
Other = 4 (*n* = 11) * 36%	3		1
Student = 3 (*n* = 7) *43%			3
Fish seller = 3 (*n* = 4) *75%		1	2

Uses reported include (Table 5):

- Skin and claws – to cure cerebral meningitis in children; some specify the skin of tail is to be used. Both also used as unspecified charms. Skin specifically is used to make hats, drums, musical instruments, a charm to improve sexual function/attraction, and when boiled to treat constipation in children.
- Claws – three reports they are used by fishermen however, these reports were based on hearsay.
- Bones – used in traditional medicine but no specifics.
- Mouth root – fishermen believe the otter has a root in its mouth that helps them catch fish; if you get one of these it will improve your catch when tied to your fishing net.
- Oil from otter – used to treat ears.
- Scats – used to treat constipation in children; believed useful because otters spread their scat everywhere.
- Meat – both species are eaten and when eaten also used to improve sexual prowess.
- Traditional medicine – several respondents reported knowing, or having heard of otters use in traditional medicine but were not specific as to how.
- It was reported that the Wampoto believe the African clawless otter uses it tail to catch crabs. This process involves dangling their tail in the water and when the crab grabs on the otter pulls its tail from the water and eats the crab.

Why do you think otters are hard to see?

- Don’t know – 25%
- Human presence/activities – 25%*
- Where they live – 31%**
- Not many otters – 6%
- People do not care about them so don’t see – 5%
- Activity cycle – 2%
- Clever animals – 3%
- Destruction of their environment – 3%

* Human presence/activities included attempts to kill, general activities, and human density in area
** Where they live included identifying far from people and need to live in “cool” location.

What is your opinion about what should be done about otters? (Based on the wording of some responses it appears that some of the interviewees may have attended a presentation by the researcher prior to participating in the survey. In these cases [all scored under Protect or Conservation Education], their responses were comments like: “good indicators of healthy environment” or “should be protected for future generations”.)

- No opinion - 21%
- Protect them - 44%*
- Eliminate them - 16%**
- Provide more education to people about conservation – 18%
- Educate people how to avoid – 1%
- Do research of various kinds – 6%***

*Protect – reasons ranged from their value to healthy ecosystems, their value in traditional medicine, as a meat source, to tourism, and simple “protect them” statements which sometimes cited “we are supposed to protect for future generations” or so “we can benefit from them”.
** All of the individuals who want them eliminated are fishermen, farmers who also fish, or owners of ponds who raise fish for income/food.
***Of those who mentioned research the goals ranged from understanding how to avoid them (fishermen), if they actually do cure cerebral meningitis, how people can benefit from them, and to better understand their conservation.

DISCUSSION

Some information on the awareness of (Stevens 2011, Akpona et al. 2015) as well as the consumptive use of, and traditional lore about spotted-necked otters and African clawless otter has been collected in Benin (Djagoun et al. 2009, Akpona et al. 2015), Ethiopia (Ergete et al. 2017), South Africa (e.g. Simelane and Kerley 1998, Whiting et al. 2013 and Tanzania (Reed-Smith et al. 2010, DeLuca and Mpunga 2012, 2013). A review of this literature indicates that overall otters are unknown by the majority of people living in Africa (e.g. only 18% of local Lake Victoria students (N = 932) provided an acceptable name for otter in a survey by Stevens (2011). Where they are known the immediate reaction is often to dislike them as in the Stevens (2011) survey in which 34% of those who knew of them disliked the otter and less than 50% of the students aware of otters wanted them nearby. Ergete et al. (2017) reported that 91% of 204 fishermen interviewed at Lake Tana, Ethiopia viewed otters (African clawless) as pests and of no economic value and 85% want them exterminated. Akpona et al. (2015) initially interviewed 165 fishermen in Benin to assess perceptions of spotted-necked otter predation and cost of this to them. Their final analysis determined that there was a demonstrable loss (~82% of which is a result of net damage) but this represented about a 9% documented loss versus the 30% estimated by the fishermen. These results and other reports indicate the negative attitudes towards the otter and damage caused by them to fishing equipment present serious hurdles to conservation of these species.

The results of this survey appear to contradict this literature in that 68% responded they liked otters and 44% stated they should be conserved. While hopeful, this positive outcome also could be influenced by consumptive use factors such as their use in traditional medicine and use as a food source. Alternatively, the high positive response rate could be attributed to a mentioned hope the otters could attract tourists to an area not often visited by international visitors, or indicative that respondents simply were aware of the researchers' interest and gave an answer that would please them. This study is in line with others in that of those who responded to "Do the otters cause you harm?" 76% of the fishermen and 82% of self-identified fishermen/farmers said they do cause harm. Eighteen percent of the survey respondents reported eating otters and 34% reported being familiar with traditional uses for otters. De Luca and Mpunga (2012, 2013) also reported on several traditional uses of otter and found that otters were eaten in southern Tanzania.

The responses to, "Why do you think otters are hard to see? are indicative of some familiarity with otters (active at night, general numbers are not high, and their behavior allows them to avoid or hide from people), and awareness of changes in the freshwater ecosystems that are harmful to all wildlife (destruction of environment).

Rural Africans, living a subsistence existence, regard any animal which has the potential to kill or consume anything belonging to them, or what they could consume themselves, as an enemy. At the same time, most wild animals are also regarded as a source of food and needed protein. A study of this type helps nature conservationists and wildlife biologists understand the people that they are dealing with and therefore develop ways of trying to impart accurate (and appropriate) knowledge. If cultural beliefs, perceptions towards wildlife, and the economic problems (real and perceived) associated with sharing their environment with animals are better understood we have a better chance of preserving Africa's otters and the freshwater ecosystems important to otters and people alike.

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Appendix A: Information Gathered and Questions Asked.

All respondents were interviewed by the same person. Questions were asked and answered in Swahili then translated into English. Some individuals had been exposed to presentations by the primary researcher (e.g. students, some pond owners, and some fishermen). How this tainted their responses is unknown but suspected to have led to some responses that they liked otters even though they caused harm. However, in the majority of those cases, the individual did state the harm was minimal. All interviews were conducted between October 2017 and October 2018.

1. Date
2. Name
3. Sex
4. Age
5. Tribal affiliation
6. Where interviewed
7. Where from
8. Occupation
9. Do you know these animals (photos of otters and mongoose shown)?
10. Do you like this animal?
11. Do they cause you harm?
12. If yes, what kind of damage (e.g. eat/damage fish, economic, damage to nets, traps, ponds)?
13. What kind of net do you use?
14. How long is it left in the water?
15. How often do they cause harm?
16. What is the cost of this harm to you?
17. How much do you earn from fishing/your pond?
18. Are you familiar with any traditional uses of otter?
19. If yes, what?
20. Is clean water important for people and wildlife?
21. Is healthy vegetation important for people and wildlife?
22. Do you have any thoughts about the environment or what should be done to care for it?
23. How many otter species do you know? Asked to identify them from the photos.
24. Is it difficult to see otters? If yes, why do you think this is?
25. What is your opinion of otters? Should they be protected, left alone, eliminated?

Appendix B: Basic Study Information

Basic Study Information (page 1)
Study Locations:
Base location Mbinga (10°57'45.10"S/ 34°57'11.36"E). The study focused on the area surrounding the town of Mbinga, Lake Nyasa shoreline, and Liparamba Game Reserve areas.
Interviews conducted in:
Burma, Changarawe, Chinura, Hongi, Jangwan, Kihagara , Kihangani, Kiliman, Lilongwe, Liparamba, Luanda, Luhununa, Lumeme, Maleta, Marungu, Matiri, Maumba, Mgangamao, Mbuyula, Miembeni, Mloweka, Mpepai, Mseto, Mtadazi, Mtua, Muhekela, Ndela, Ndilima, Ng'ombo, Njombe, Pacha sita, Pachani, Raha Leo, Ruvumua Chini, Songambele, Tugutu, Tumbi towns or villages. Also at, Mbuyula and Chinura beaches on Lake Nyasa and Kisangani Mwalo and Hongi fishing centers (36 L 0676612, UTM 8781908; 36L 0680461, UTM 8768924).
Respondents reported being from:
Liparamba, Mibinga, or Lake Nyasa areas.
School programs conducted at:
Limbo secondary (36 L 0700062, UTM 8748646) with 427 students; Linda Primary (36 L 0700298, UTM 8747003) with 293 pupils; Kilosa Primary (36 L 0698797, UTM 8749464) with 495 pupils; Lukwilu Primary (36 L 0700921, UTM 8748646) with 223 pupils; Kihagara Primary (36 L 0678192, UTM 8781941) with 284 pupils; Mbahi Primary (36 L 0679707, UTM 8782571) with 241 pupils; Mtomoni Primary (36L0765229, UTM 8722384) with 342 students, and Hongi Primary School (36 L 0680636, UTM 8769996) with 213 students equaling 2,518 students reached with educational material on conservation, the value of freshwater ecosystems and the role otters play in these habitats.
Community visits:
Informal discussions and presentations were conducted in all communities visited, including the area around the Liparamba Game Reserve (~90 farmers and park staff), Lake Nyasa fishermen, pond owners and two community leader groups. A total of roughly 150 fishermen along the shores of Lake Nyasa, 30 fish keepers (pond owners) and 700 farmers or villagers participated in discussions about conservation and the area's otters. These meetings included the use of photos to identify the otter species, a short talk about the biology of otters, and a discussion about the participants' familiarity with, and reaction to the otters they encounter. The 250 survey participants were selected from these communities. Most were interviewed prior to meetings but not all.
Otter fish pond depredation mitigation:
One pond in the Mbinga area (36 L 0723821, UTM 8795027) was used to test an exclusionary fence of chain link. This will slowly be replaced by a natural fence of pineapple plants.
Camera trap work:
The camera trap has been set up at the fenced fish pond for the last 8 months and to date has not produced any photos of otter incursions to the pond.
Local names for otter:
Swahili – fisi maji mkubwa (African clawless), fisi maji koo madoa (Spotted-necked); Kimatengo - likarangala likolongu likijivu (African clawless), likaranga gagabii na madoa (Spotted-necked); Kinyasa - chiucha nakolongwa wa Afrika (African clawless), chiucha ayina madoa (Spotted-necked); Wampoto – linkarankara (African clawless), huchwa (Spotted-necked).

Basic Study Information (page 2)

Tribal Affiliations

Respondents reported as being from the following tribes: Matengo (104), Mkisi (3), Mmanda (5), Mindi (1), Mnyasa (64), Mpangwa (2), Mpoto (12), Ndendeule (2), Ngoni (56), Yao (1) (*N* = 250). There was no correlation with tribe and attitude towards otter or knowledge of traditional uses.

Gender and Age of Respondents:

Ages were arbitrarily grouped to reflect school age as well as early, middle, and later work careers and exposure to traditional stories or cultural influences.

Male	196
Female	54
Under 20 years of age	18 (range 15 – 19)
20 to 29 years of age	60 (range 20 – 29)
30 to 39 years of age	76 (range 30 – 39)
40 to 49 years of age	50 (range 40 – 49)
Over 50 years of age	49 (range 50 – 83)

Occupation of Respondents:

Fishermen/farmers may rely on one or the other of the occupations but indicate a greater likelihood of experiencing interactions with otters owing to fishing experience. Pond owners are most often also farmers; fish are kept for personal protein use and to sell. Of the four fish sellers three were farmer's wives and the fourth sold "dagaa" in the market. The "Other" category contains people working in professions not directly involved in fishing, fish keeping, or farming (i.e. teachers, drivers, business men, etc.) There is some correlation between occupation and attitude towards otter and traditional beliefs.

Farmers	Fishermen	Fishermen/farmers	Fish sellers	Pond owners	Students	Other
98	41	62	4	27	7	11

Appendix C: Respondent breakdown – Women versus Men

Respondent breakdown – Women versus Men					
Women = 54			**Men = 196**		
Tribe	**Occupation***	**Age Group**	**Tribe**	**Occupation***	**Age Group**
Matengo = 22	Farmer = 36	<20 = 8	Matengo = 82	Farmer = 61	<20 = 10
Mnyasa = 17	Student = 6	20-29 = 18	Mnyasa = 47	Fisherman/farmer = 62	20-29 = 40
Ngoni = 10	Other = 5	30-39 = 17	Ngoni = 46	Fisherman = 41	30-39 = 55
Mpoto = 4	Fish Seller = 4	40-49 = 6	Mpoto = 8	Pond owner = 25	40-49 = 47
Ndendeule = 1	Pond owner = 3	50+ = 5	Mmanda = 5	Other = 6	50+ = 44
			Mkisi = 3	Student = 1	
			Other tribes = 5 (1, 1, 1, 2)		
***Fishermen/farmers identified as engaged in both occupations. Pond owners are also farmers. Women May not have mentioned ownership of a pond and were not asked the occupation of their spouses which may have influenced the high awareness of spotted-necked otters if they are married to fishermen/farmers. Other category includes all engaged in other businesses except self-identified fish sellers.					
Know Otters (n = 54)	**Identify Species (n = 50)**	**Like or Don't Like**	**Know Otters**	**Identify Species**	**Like or Don't Like**
Yes = 49	Spotted = 32	Yes = 32	Yes = 190	Spotted = 81	Yes = 137
No = 1	Clawless = 15	No = 12	No = 4	Clawless = 66	No = 50
Heard of = 4	Did not ID = 2	Don't know = 10	Heard of = 2	Did not ID = 7	Don't know = 9
	ID both = 1			Both = 42	
Cause harm	**Traditional Uses** (some reported more than one)		**Cause harm**	**Traditional Uses** (some reported more than one)	
Yes = 10	None known = 27		Yes* = 109	None known = 70	
No = 44 (81%)	Cure cerebral meningitis = 6		No = 87	Cure cerebral meningitis = 21	
	Skin for hats, drums, traditional dress = 8		* 42 stated not much harm	Skin for hats, drums, traditional dress = 27	
	Skin/meat for erectile dysfunction = 2			Skin/meat for erectile dysfunction = 2	
	Claw/mouth root to improve fish catch = 3			Claw/mouth root to improve fish catch = 35	
	Eaten = 3			Eaten = 52	
	Heard of only = 6			Heard of only = 15	
				Cure constipation = 3	
				Oil to treat ears = 3	
Should otters be protected or destroyed?			**Should otters be protected/conserved?**		
Protected = 36			Protected = 121		
Destroyed = 7			Destroyed = 36		
No opinion = 11			No opinion = 39		

Appendix D: Women versus Men by Occupation

Women (n = 54) versus Men (n = 196) by occupation

Photographs of both otter species and the marsh mongoose were shown to participants. They were asked if they knew the animals, if they liked them, and which species they see. Mongoose IDs were not kept. Respondents were interviewed separately. M = male, F = female; only categories with one or more respondents listed.

Do you know this animal?

Occupation	Know	Don't know	Heard of them
M farmers (n = 61)	57 (93%)	2	2
F farmers (n = 36) *****	33 (92%)	1	2
M fishermen/farmers (n = 62)	62 (100%)	0	0
M fishermen (n = 41)	41 (100%)	0	0
M pond owners (n = 25)	24 (96%)	1	0
F pond owners (n = 3)	2 (66%)	0	1
M Other (n = 6)	5 (83%)	1	0
F Other (n = 5)	4 (80%)	0	1
M Student (n = 1)	1 (100%)	0	0
F Student (n = 6)	6 (100%)	0	0
F Fish seller (n = 4)	4 (100%)	0	0

*** F farmers** could be married to men who identified as fishermen/farmers.

Do you like this animal?

Occupation	Yes	No	Don't know
M farmers (n = 61)	49 (80%)	10	2
F farmers (n = 36)*	23 (64%)	10	3
M fishermen/farmers (n = 62)	43 (69%)	16	3
M fishermen (n = 41)	24 (50%)	16	1
M pond owners (n = 25)	16 (64%)	7	2
F pond owners (n = 3)	0	1	2
M Other (n = 6)	4	1	1
F Other (n = 5)	3	0	2
M Student (n = 1)	1	0	0
F Student	6	0	0
F Fish seller (n = 4)	0	1	3

What species identified?

Occupation	Spotted	Clawless	Both	Neither
M farmers (n = 61)	2	49 (80%)	5	5
F farmers (n = 36)	18 (50%)	13	1	4
M fishermen/farmers (n = 62)	45 (66%)	4	13	0
M fishermen (n = 41)	31 (76%)	0	10	0
M pond owners (n = 25)	1	11	13 (52%)	0
F pond owners	0	2	0	1
M Other (n = 6)	1	2	1	2
F Other (n = 5)	4	0	0	1
M Student (n = 1)	1	0	0	0
F Student (n = 6)	6	0	0	0
F Fish seller (n = 4)	4	0	0	0

Do otters cause you harm?

Occupation	Yes	No	Don't know
M farmers (n = 61)	8	53 (87%)	0
F farmers (n = 36)*	7	29 (81%)	0
M fishermen/farmers (n = 62)	51 (82%)**	11	0
M fishermen (n = 41)	31 (76%)***	10	0
M pond owners (n = 25)	18 (72%)****	7	0
F pond owners	2	1	0
M Other (n = 6)	1	5	0
F Other (n = 5)	0	5	0
M Student (n = 1)	0	1	0

F Student (n = 6)	0	6	0
F Fish seller (n = 4)	1	3	0
** Of the 51 male **fishermen/farmers** who answered otters cause them harm, 21 qualified it as "not much". ***Of the 31 **fishermen** reporting harm, 10 qualified as "not much". **** Of the 31 **pond owners** who answered otters cause them harm, 9 qualified as "not much".			

Do you know of traditional/consumptive uses of otter? (Some mention >1)							
Occupation	**M**	**Eaten**	**None**	**MR**	**Skin**	**ED**	**Heard**
M farmers (n = 61) **F** farmers (n = 36)*	20 (33%) 5	4 1	28 18	0 2	9 4	0 1	3 4
M fishermen/farmers (n = 62)	1	26	17	18 (29%)	7	0	5
M fishermen (n = 41)	0	8	16	17 (41%)	2	2	4
M pond owners (n = 25) **F** pond owners	0 1	13(52%) 0	5 2	0 0	9 1	0 0	1 0
M Other (n = 6) **F** Other (n = 5)	0 0	1 2	3 3	0 0	0 1	0 0	2 0
M Student (n = 1) **F** Student (n = 6)	0 0	0 0	1 3	0 0	0 1	0 0	0 2
F Fish seller (n = 4)	0	0	1	1	1	1	1
M = cure for cerebral meningitis in children; **MR** = mouth root used to increase fish catch; **Skin** = used to make hats, for drums, ceremonial items; **ED** = meat and skin used to cure erectile dysfunction; **Heard** = heard of uses but not specified.							

RESUME
EVALUATION DU COMPORTEMENT DE L’HOMME FACE AUX LOUTRES DANS LE DISTRICT DE MBINGA EN TANZANIE

Une enquête de type questionnaire a été réalisée auprès des résidents ruraux du district de Mbinga, dans le sud de la Tanzanie. Deux cent cinquante personnes, âgées de 15 à 84 ans, ont été interrogées, parmi celles-ci des agriculteurs, des agriculteurs/pêcheurs, des pêcheurs et d'autres personnes. Les informations recueillies chez les personnes interrogées concernaient leur connaissance des deux espèces de loutres (*Aonyx capensis* et *Hydrictis maculicollis*), leurs acceptations et rejets des loutres, les dégâts au matériel, aux poissons dans les filets et les étangs, la perception de l'impact sur les populations de poissons, les coutumes traditionnelles et leurs utilisations. Des avis sur la conservation et la gestion futures des loutres ont été obtenues. Toutes les réponses ont été corrélées avec l'appartenance tribale, les professions, le sexe et l'âge des personnes interrogées. Les résultats seront utilisés pour mieux comprendre les opinions et attitudes des habitants locaux concernant les loutres et orienter la conception de matériel de sensibilisation à la conservation des eaux douces afin de répondre aux besoins de la population et de la faune sauvage. L'élaboration de ce futur programme mettra l'accent sur la nécessité de faire preuve d'empathie quant aux exigences et perceptions économiques humaines lors de la conception d'un plan acceptable et réalisable au profit de la conservation des loutres et de leur environnement.

RESUMEN
EVALUACIÓN DE LAS ACTITUDES HUMANAS HACIA LAS NUTRIAS EN EL DISTRITO DE MBINGA, TANZANIA

Condujimos una encuesta con cuestionarios, entre los residentes rurales del distrito de Mbinga, sur de Tanzania. Entrevistamos a 250 personas, de edades entre 15 y 84 años, abarcando campesinos, campesinos/pescadores, pescadores, y otros. Recolectamos información sobre el conocimiento de los encuestados acera de las dos especies de nutrias de la zona (*Aonyx capensis* e *Hydrictis maculicollis*), su gusto o disgusto para con las nutrias, daños a sus equipamientos, peces capturados en redes, peces en estanques, impactos percibidos sobre las poblaciones de peces, conocimientos tradicionales, y qué usos se hacen de las nutrias. Pedimos opiniones sobre la futura conservación y manejo de las nutrias. Todas las respuestas fueron correlacionadas con la pertenencia tribal, ocupaciones, sexo y edades de los que respondieron. Los resultados serán utilizados para entender mejor las opiniones y actitudes de los habitantes locales respecto de las nutrias, y guiar la creación de materiales de difusión sobre conservación en agua dulce, de manera que se tengan en cuenta las necesidades de la gente y de la fauna. El desarrollo de este programa futuro pondrá énfasis en la necesidad de empatizar con los requerimientos económicos y percepciones humanos al momento de crear un plan aceptable y viable, que beneficie la conservación de las nutrias y su ambiente.

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ARTICLE

INFLUENCE OF EURASIAN BEAVER (*Castor fiber*) ON EURASIAN OTTER (*Lutra lutra*) EVALUATED BY ACTIVITY DENSITY ESTIMATES IN ANTHROPOGENIC HABITATS IN EASTERN GERMANY

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Abstract: The semiaquatic mammalian species Eurasian beaver *Castor fiber* LINNAEUS, 1758 and Eurasian otter *Lutra lutra* (LINNAEUS, 1758) simultaneously occur in European freshwater ecosystems. Knowledge about the interaction between the two species can be helpful in the prediction of species distribution and colonization. The present study compares beaver and otter activity densities of the winter season 2015/2016 in anthropogenic habitats in eastern Germany. Beaver activity was assessed using tree cuts, otter activity using spraints. The results indicated that otter activity was only slightly influenced by beaver activity (2 % less otter activity for a unit increase in beaver activity, *P*=0.013), probably because the study area already provides optimal hunting grounds in terms of fish supply for the otter. Additional results obtained from biennial camera trap data, collected between 2015 and 2017, pointed to temporal segregation of the two species during low water periods (*P*<0.0001). According to our population size estimates for the otter using DNA microsatellite markers and rarefaction, the study area is densely populated by otters (1.46 otters per km river shoreline), whereas the beaver population size, based on identification of territories, indicated suboptimal habitat conditions (1.15 beavers per km shoreline).

Key words: Activity density; Anthropogenic habitats; Camera trap; DNA fingerprinting; Habitat preferences; Interspecific relationship; Population size estimation

INTRODUCTION

Little is known about the interspecific behaviour of the semiaquatic mammalian species Eurasian beaver *Castor fiber* LINNAEUS, 1758 and Eurasian otter *Lutra lutra* (LINNAEUS, 1758) (Ulevičius and Balčiauskas, 1999; Gallant and Sheldon, 2008). Both species simultaneously occur in European freshwater ecosystems. Until recently, however, the otter was intensively pursued mainly due to its role as a fish predator in fisheries, which led to a rapid decline of otter populations all over Europe (Mason and Macdonald, 1986; Klenke et al., 2013). At the same time, beavers were mainly hunted for fur and castoreum, such that they became largely extinct and only survived in small, isolated populations scattered across Europe (Halley, 2011). As a consequence, studies of interaction between beavers and otters were almost unfeasible in Central Europe until mid of the last century. Hence, most of the work available on the topic applies to the North American beaver (*Castor canadensis*) and the North American otter (*Lontra canadensis*) (Green, 1932; Tumlison et al., 1982; Melquist and Hornocker, 1983; Reid et al., 1988; Swimley et al., 1999, Collen and Gibson, 2000). If the relationship between the North American beavers and otters also applies to the corresponding Eurasian species, remains unclear. It seems likely, however, that the relationship between the Eurasian species is similar to the one in North America due to the largely comparable way of living and behaviour patterns of Eurasian and North American beavers and the almost identical food preferences of the Eurasian and North American otters (Campbell-Palmer and Rosell, 2015). The relation of *C. canadensis* and *L. canadensis* is described as commensal (Tumlison et al., 1982), such that the building activity of the beaver in terms of dams and resulting beaver ponds is considered to have a positive impact on the survival rate, reproductive success, and species diversity of the fish community (Collen and Gibson, 2000). Hence, beaver ponds represent optimal habitats and hunting grounds for the otter due to the increased amount of available fish, which is the otter's main prey (Tumlison et al., 1982). With regard to more direct species interactions, North American otters are occasionally observed sleeping in abandoned beaver lodges (Swimley et al., 1999), peacefully living together with beavers in the same lodge (Melquist and Hornocker, 1983), but also expelling beavers from their lodges to occupy them for their own purposes (Reid et al., 1988). Older works even document an active predation of otters against beavers (Green, 1932).

With respect to the Eurasian species *C. fiber* and *L. lutra*, field observations of direct interactions between beavers and otters are inconclusive (see e.g. Semjonow (1951) and Romanowski et al. (2010)). A more quantitative, but indirect approach of studying the interaction is presented in the work by Sidorovich et al. (1996), who found a positive correlation between otter number and beaver settlements in Belarus. However, the correlation depended on river width, such that wider rivers with a larger number of beaver settlements did not entail a proportionally larger number of otters (Sidorovich et al., 1996). Hence, in order to accurately assess the effect of beaver activity on otter presence, otter-specific habitat correlates for the study area need to be identified as potential confounders prior to interaction analysis.

Another way to study activity patterns of elusive species such as beavers and otters are camera traps (Guter et al., 2008; Karamanlidis et al., 2014; Swinnen et al., 2015). The analysis of camera trap data might reveal dissimilarities of activity patterns between beavers and otters, which would indicate temporal segregation, i.e., time shifts in activity peaks (Niedballa et al., 2019), during shore leaves.

Population size estimates provide valuable information as to the population status, especially for such elusive species like beavers and otters, which is helpful to assess the validity of the results gained from statistical analyses that focus on interspecific relationships. Beaver population size is usually estimated by identifying the number of territories based on tree cuts (Schwab and Schmidbauer, 2001). Otter population size can be estimated by DNA fingerprinting (Bruford and Wayne, 1993) using non-invasive genetic sampling of spraints (Kohn and Wayne, 1997).

In summary, the aim of the present study was to compare beaver and otter activity densities by means of correlation analysis and complex regression modelling, including potential confounders for habitat selection and species detectability in an anthropogenic environment in eastern Saxony, Germany, which is populated by beavers and otters. Measures of activity density were defined as weighted sums of either fresh or old tree cuts per river section for the beaver and the absolute number of spraints per river section for the otter (Almeida et al., 2013). Furthermore, we analysed camera trap data gathered for 2 years to evaluate – although limited to a single, but highly frequented land corridor – dissimilarities in activity patterns of the two species. Because there are no current beaver and otter population size estimates available for the study area, we also provided population size estimates for beavers and otters based on the identification of beaver territories and DNA fingerprinting using otter spraints, respectively.

STUDY AREA

The study area comprised the rivers Spree and Lusatian Neisse in Upper Lusatia, Saxony, Germany (Figure 1). It is lowland, with agricultural use mostly close to the riverside and only a few patches of riparian forests. On its way north, the Spree traverses the Upper Lusatian Heath and Pond Landscape biosphere reserve, which is characterized by a multitude of fish ponds, which are mostly surrounded by reeds and woodlands. These ponds are connected by a network of ditches with often natural-like bank structures. Further north, the Spree is part of a post-mining landscape and therefore regulated.

The floodplain of the Lusatian Neisse is characterized by meadows and only a small number of fish ponds in the surroundings. Further, two tributaries of the Spree, i.e., Schwarzer and Weißer Schöps, as well as few other small streams and channels of the catchment area of Spree and Lusatian Neisse were selectively investigated. The corresponding surroundings encompass several fish ponds with connecting channels between them. Due to mild winters, rivers of the study area are usually not completely covered by ice, and fish ponds do not regularly freeze up, but most of them are drained during wintertime. Feeding conditions for the otter are very good due to the high availability of fish in ponds and rivers (Füllner et al., 2016). Due to the lack of extensive riparian forests and natural riverbanks in the study area, food availability for the beaver in terms of herbs and softwood is limited.

Beaver and Otter Populations of the Study Area

Since their first reappearance in 1999 (Hertweck and Hieke, 1999), beavers have gradually colonized the Lusatian Neisse and eventually also the Spree (Pannach, 2011). Beavers of the Lusatian Neisse most likely originate from recolonization projects in Poland and are usually assigned to belong to the *Castor fiber vistulanus* Matschie (1907) subspecies (Hertweck and Hieke, 1999), which is also referred to as the hybridization result of the *Castor fiber orientoeuropaeus* Lavrov (1981) and *Castor fiber belorussicus* Lavrov (1981) subspecies (Durka et al., 2005).

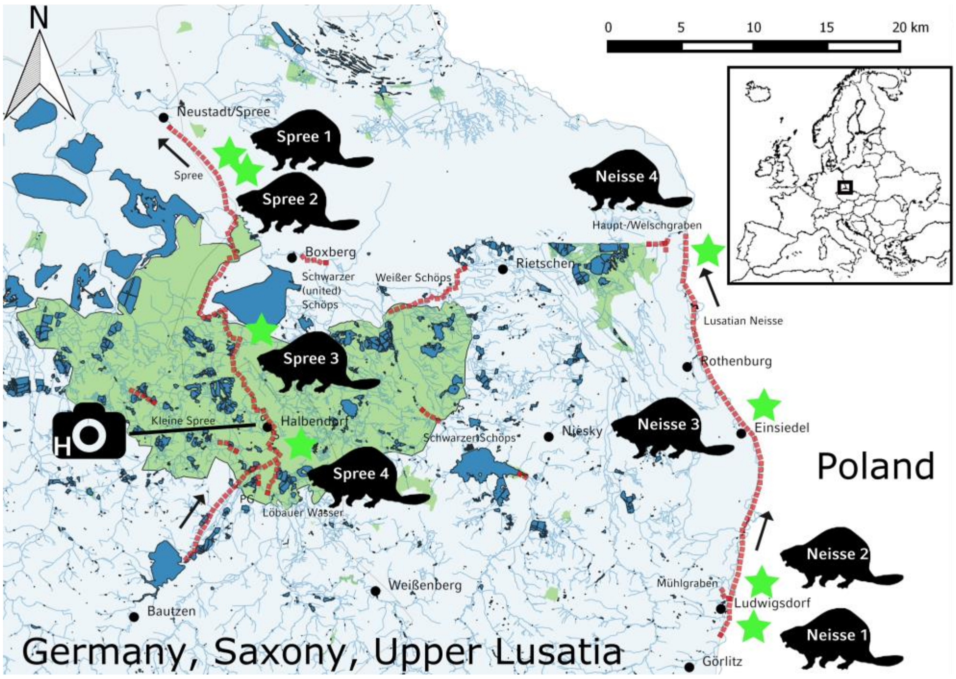

Figure 1. Overview of the study area in Upper Lusatia, Saxony, Germany. Investigated river sections (Spree and Lusatian Neisse) are depicted by red rectangles. Beaver territories, which were selected for additional analyses, are marked by beaver pictograms and green stars. It is of note that there was only a single flanking section between beaver territories Spree 1 and 2 as well as between Neisse 1 and 2. The location of the camera trap is marked by a camera pictogram. Green, bordered area: Upper Lusatian Heath and Pond Landscape biosphere reserve; other green areas: conservation areas. Black arrows indicate the direction of river flow. Black rectangle in the small inlet map of Europe marks the location of the study area. © Federal Agency for Cartography and Geodesy, Frankfurt am Main, 2011; Geofabrik GmbH and OpenStreetMap contributors, 2015.

Beavers of the Spree might originate from the eastern *C. f. vistulanus* population as well as from the autochthonous *Castor fiber albicus* MATSCHIE (1907) population, which escaped the European extinction period during the 19th century as a relict population in the middle Elbe region (Durka et al., 2005). With regard to the otter, the population of the present study area is considered to be one of the most viable otter populations in Europe (Ansorge, 1994) and escaped extinction during the 20th century as a relict population in the study area.

METHODS

Survey Method and Period

The general survey method for both species was based on the standard procedure for the otter, such that the river was surveyed in 600 m sections along either riverside (Reuther et al., 2000). The specific method for the beaver survey was based on the works by Schwab and Schmidbauer (2001) and Heidecke (2005). Recorded beaver signs included beaver cuts, which were visually categorized into fresh and old cuts and three size ranges (1, 2-5, and > 5 trees or shrubs within a radius of 5 m) including the main tree or shrub species, beaver runs, footprints, dams, and lodges. Recorded otter presence signs included the number of spraints per sprainting site within a radius of 1 m, footprints, holts, and feeding sites. The Spree was sampled from October 2015 to January 2016 between the water reservoir Bautzen in the south (51.214° N, 14.471° E) and the village Neustadt/Spree in the north (51.480° N, 14.460° E), which corresponded to 48.6 km shoreline (Figure 1, left). The Lusatian Neisse was sampled from November 2015 to January 2016 between the villages Ludwigsdorf in the south (51.177° N, 15.005° E) and Steinbach in the north (51.420° N, 14.966 °E), which corresponded to 58.8 km shoreline (Figure 1, right). Further, two tributaries of the Spree, i.e., Schwarzer and Weißer Schöps, as well as few other small streams and channels of the catchment area of the Spree and the Lusatian Neisse were selectively sampled from January to April 2016, which corresponded to 24.6 km shoreline. During the above-mentioned survey periods, all river sections were sampled once in a consecutive manner. In addition, we investigated eight beaver territories and flanking sections at the Spree and the Lusatian Neisse, which had been identified before during the corresponding main survey periods (Figure 1, beaver pictograms). This additional survey took place between January and April 2016.

Activity Density Estimates

Current and former beaver activity densities were estimated as the sum of fresh and old tree cuts, respectively, weighted by their extent (1, 2-5, and > 5 trees or shrubs within a radius of 5 m), per investigated river section. In the case of the otter, the activity density estimate was calculated as the number of spraints collected per investigated river section (Almeida et al., 2013), which positively correlates with the actual number of otters and can hence be used as a semi-quantitative measure of population size and habitat usage (Guter et al., 2008; Almeida et al., 2013; Romanowski, 2013).

To get a closer view on the interspecific interaction, correlations between beaver and otter activity densities in distinct beaver territories (activity centres of home ranges, see Vorel et al. (2008)) and flanking river sections were investigated in an additional survey. Here, only fresh beaver tree cuts, together with beaver scats and deposited castoreum, were assessed along with otter presence signs. The primary outcome of this subanalysis was defined as the number of otter spraints per river section.

Camera Trapping

We assessed and compared activity patterns of beavers and otters as a function of daytime hour, month, and moon phase in our study area by the use of a camera trap. The camera (HC 600 HyperFire camera trap, Reconyx, Holmen, USA) was installed at a highly frequented land corridor between the Spree and one of its abandoned meanders in the Upper Lusatian Heath and Pond Landscape biosphere reserve (Figure 1). Data was collected between February 2015 and March 2017 with two gaps without data from 2016/08/04-2016/10/07 and 2016/11/10-2016/12/23 due to technical problems. The activity density estimates for both species were calculated as corridor traverses per daytime hour (0-23) and month (January-December). Activity patterns were obtained by visual inspection of the pictures without identification of individuals except for temporally close traverses.

Habitat Assessment

Assessment of habitat features was done for beavers and otters jointly using the otter habitat evaluation form by Peper and Peper (1996), which is given in Table 1. Further critical habitat features were adapted from the beaver and otter habitat evaluation forms by Hauer (2005a,b), which are given in Table 2. In addition, we recorded habitat features that may influence otter colonization success or are potential confounders for the detectability of otter presence signs (Romanowski, 2013; Romanowski et al., 2013), which can be found in Table 3.

Table 1: Field survey Otter habitat evaluation form from Peper and Peper **(1996)**

Habitat features for streaming water (Peper and Peper, 1996)

Habitat feature (score points)	(1)	(2)	(3)	(4)	(5)
Stream nativeness	Encased in pipes	Engineered	Regulated, with stabilization	Regulated, without stabilization	Natural
Bank nativeness	Massive riverbed and bank	Stabilized riverbed and bank	Riverbed and bank as standard section	Bioengineered	Natural
Structural features in water	None	Few	Calm sections, diversified	Diversified, versatile	Torrent
Shoreline stabilization	Encased in pipes	Masoned, paved	Stone packing	Mostly biological	Natural
Riverine vegetation	None	Grassland, permanent agriculture	Herbs, shrubs, scattered woods	Woods, partly planted	Woods on both riversides, old growth

Table 2. Habitat features relevant to otters as assessed during the field survey.

Habitat features relevant for otters (adapted from Hauer, 2005a,b)

Habitat feature (scoring A, B, C)	A	B	C
Water quality score (derived from Table 1)	≥ 20	$13 - 19$	< 13
Land use of surroundings (100 m)	No intensive land use 50 m from bank, no buildings and traffic	Mostly extensive land use 50 m from bank, few buildings, little traffic	Intensive land use up to the bank, many buildings, high traffic
Spatial coherence of habitat	Optimal interconnectedness, no migratory barriers	Suboptimal interconnectedness, migration in at least two directions without barriers	Strong fragmentation, migration only unidirectional
Food availability for the otter	Optimal; perennial fish and other prey supply	Suboptimal; fish and other prey supply season-dependent	Pessimal; few fish and other prey
Threat due to road traffic	None; free passage underneath crossroad bridges, > 90% otter tunnels, inclination road - water > 45°, few minor roads within 100 m	Minor; passage underneath crossroad bridges only blocked during flood, 75 – 90% otter tunnels, inclination road - water > 20°, no major roads within 100 m	Major; no secure passages, < 75% otter tunnels, major roads within 100 m, fragmentation of water bodies, known road casualties
Human disturbance	None; no fishing, little recreational use	Minor; little fishing and recreational use, hunting unlikely	Major; fishing and recreational use, crop damage, hunting expectable

Table 3. Additional habitat features and potential confounders for otter sign detectability as assessed during the field survey. * See also Romanowski (2013)

Additional habitat features and potential confounders for species sign detectability

Weather	Sunny (reference)	Bright	Cloudy	Rainy	Snowy
River width (m)					
Shrub coverage of riverside (%)					
Humans*	Low (< 1 presence sign per 100 m shoreline)	Average (1 – 10 presence signs per 100 m shoreline)	High (> 10 presence signs per 100 m shoreline)		
Domestic animals*	Low (< 1 presence sign per 100 m shoreline)	Average (1 – 10 presence signs per 100 m shoreline)	High (> 10 presence signs per 100 m shoreline)		
Buildings within 50 m from the riverside*	Yes	No			
Standing water within 500 m from the riverside	Yes	No			
Potential sprainting sites*	Few (< 1 per 100 m shoreline)	Many (> 1 per 100 m shoreline)			
Distance searched until first spraint discovery (m)*					
Presence of anthropogenic damming structures	Yes	No			
Number of bridges with certain sprainting potential*	Low (< 10% of area under the bridge suitable for finding spraints)	Average (10 – 50% of area under the bridge suitable for finding spraints)	High (> 50% of area under the bridge suitable for finding spraints)		

Scores for all habitat features and potential confounders in Tables 1–3 were averaged over independent estimates of two researchers and were assessed in the field without further auxiliary data.

Statistical Analysis

Field Survey Data

The survey data was analysed separately for each river system (Spree, Lusatian Neisse, other streams) in an explorative manner using variable-by-variable testing to identify habitat features and potential confounders relevant to colonization success and sign discovery, respectively. In addition, presence signs of the beaver were also considered in the correlation analysis. The primary outcome, i.e., the activity density estimate for the otter was defined as the number of spraints per river section. Differences in activity density were assessed using non-parametric tests, because the otter activity density estimate is a non-normally distributed outcome. In the case of a two-sample problem, exact Mann-Whitney U tests were applied (Mann and Whitney, 1947). In the case of more than two groups without a specified order, the H test by Kruskal and Wallis (1952) was used, and when the group assignments corresponded to a specified order, the Jonckheere-Terpstra trend test was used instead (Jonckheere, 1954). *P* values for the H test and the Jonckheere-Terpstra trend test were simulated using 1,000,000 permutations under the null hypothesis of no difference in activity density between species. Correlations between activity density and continuous variables were tested using Spearman's correlation coefficient ρ. *P* values under the null hypothesis of no correlation were simulated using 100,000 replicates. In the case of the subanalysis in beaver territories, confidence intervals for the Spearman correlation coefficient were obtained using 10,000 bootstrap replicates (Efron and Tibshirani, 1993). Due to the explorative nature of the variable-by-variable analysis, $P \leq 0.05$ was considered significant, except for the separate subanalysis of beaver territories, which were corrected for multiple testing using the method by Benjamini and Hochberg (1995). All calculations were done using the statistical analysis software *R* (R Core Team, 2018). Calculation of H, Jonckheere-Terpstra trend, Mann-Whitney U, and Spearman correlation tests were done using the *R* package *coin* (Hothorn et al., 2006). Confidence intervals for the Spearman correlation coefficient were obtained using the *R* package *RVAideMemoire* (Hervé, 2016).

With regard to the regression model, the primary outcome was defined as the activity density estimate of the otter based on spraint counts per river section. Therefore, a generalized linear regression model for count data was used, which was selected on the basis of the *Bayesian Information Criterion* (*BIC*) (see e.g. McElduff et al. (2010) for the general selection procedure). Selection based on *BIC* was applied to a basic model including predefined fixed confounders, i.e., number of bridges, potential sprainting sites, presence of anthropogenic damming structures, river system (Spree, Lusatian Neisse, other streams), and weather, and using Poisson, zero-inflated Poisson, negative binomial, zero-inflated negative binomial, and hurdle models. Subsequently, all other explanatory, non-confounding variables in Table 4 were added to build up the full model. In addition, the weighted sum of fresh beaver cuts was also included in the full model to assess the impact of beaver activity on otter activity. Model selection on the non-confounding variables of the full model was based on the *Akaike Information Criterion* (*AIC* (Akaike, 1974)), except for the beaver activity as the variable of interest. Normality of residuals and goodness of model fit were investigated using a quantile-quantile plot of randomized quantile residuals and a rootogram (Kleiber and Zeileis, 2016), respectively. A rootogram visually compares the observed and fitted values of the activity densities. Multi-collinearity between variables was formally tested using the variance inflation factor (VIF) or, in the case of categorical variables, using the generalized VIF (GVIF (Fox and Monette, 1992)).

The final number of predictors for the regression model was chosen, such that it still met the 10-observations-per-variable rule of thumb (Draper and Smith, 1998).

Regression analyses and model selection were carried out using the software package *R* (R Core Team, 2018). More specifically, the following additional *R* packages were used: *countreg* (Zeileis and Kleiber, 2018) for zero-inflated and hurdle models as well as regression diagnostic plots, *MASS* (Venables and Ripley, 2002) for the negative binomial regression, and *glmulti* (Calcagno, 2013) for the model selection based on *AIC*. $P \leq 0.05$ for regression coefficients was considered statistically significant.

Camera Trap Data

Analysis of activity patterns as determined by camera traps was done using the permutation test for temporal segregation as described in Niedballa et al. (2019). Specifically, the coefficient of overlap $\hat{\Delta}_1$ (Ridout and Linkie, 2009) was calculated using the *R* package *overlap* (Meredith and Ridout, 2017) for the variables daytime (0-23 h) and month (1-12). The coefficient $\hat{\Delta}_1$ ranges from 0 (complete temporal segregation) to 1. *P* values were simulated using 10,000 replicates under the null hypothesis of equality of the activity patterns of beavers and otters, i.e., $\hat{\Delta}_1$, for both investigated outcomes. Differences in activity patterns with $P \leq 0.05$ were considered statistically significant.

Population Size Estimation of the Beaver

Beaver population size was estimated by identifying the number of territories using the method by Schwab and Schmidbauer (2001), which assigns beaver territories on the basis of activity density centres measured by tree cuts. Accordingly, beaver territories are further divided into single/couple (1.5 beavers on average) or family (5 beavers on average) territories, thus allowing for the estimation of the number of individuals.

Population Size Estimation of the Otter

Sampling of Otter Spraints

Otter scats were sampled at 9 sprainting sites between January and February 2016 at the Spree and 10 sites between February and April 2016 at the Lusatian Neisse, such that the maximum distance between two consecutive sites did not exceed 15 km, which can be considered the lower bound of otter habitat requirements (Jenkins and Burrows, 1980; Green et al., 1984; Kruuk et al., 1993; Durbin, 1996; Durbin, 1998; Sulkava, 2006). Frequently used sprainting sites as identified during the previous field survey were selected for sampling, irrespective of the corresponding type of surroundings (e.g. natural or disturbed). Sprainting sites were cleaned prior to the first sampling day to provide optimal DNA quality, which is generally low for non-invasive otter scat samples (Hájková et al., 2006; Lampa et al., 2008). In addition, jelly spraints and spraints deposited on fresh-fallen snow were sampled as well without prior site cleaning. Spraints were collected in 40 ml 96 % ethanol, jelly spraints and occasionally mucous coats of spraints were sampled using sterile cotton swabs and stored in plastic bags with silica gel as drying agent.

DNA Extraction

Lysis and DNA extraction from otter jelly was done using the QIAamp-DNA-Investigator-Kit (Qiagen, Hilden, Germany). DNA from otter spraints was extracted using the QIAamp-DNA-Stool-Mini-Kit (Qiagen). All steps were performed according to the manufacturer's protocol in a dedicated laboratory for non-invasive samples. Purification and elution of DNA was performed by the automated extraction robot QIAcube (Qiagen). Extracted DNA was stored at 4 °C prior to further analysis.

mtDNA analysis

Species identification was done by amplification of the hypervariable mtDNA control region (Meyer et al., 1990) using the primer combinations L15995 (5'-CTCCACTATCAGCACCCAAAG-3') and H16498 (5'-CCTGAAGTAAGAACCAGATG-3') (Pun et al., 2009) for otter samples. More details about the amplification procedure can be found in Frosch et al. (2014). Sanger sequencing of the amplicons was performed on an ABI 3730 DNA Analyzer (Applied Biosystems, Waltham, USA) using primer L15995. Sequences were blasted against reference sequences of the NCBI Genbank (www.ncbi.nlm.nih.gov/genbank/) using the BLAST utility function (Johnson et al., 2008). Sequences that were assigned to otters were aligned using the computer programs Bioedit (Hall, 1999) and Sequencher (Gene Codes Corporation, Ann Arbor, USA). The otter mtDNA haplotypes were classified according to the nomenclature in Mucci et al. (2010). It is of note that with the analyzed control region fragment, we were only able to distinguish the otter haplotypes 7/8 and 12 from the remaining 17 haplotypes described in Mucci et al. (2010), which, however, was sufficient to assign haplotypes to each sample of our study area.

Otter Microsatellite Analysis

Genotyping of otter DNA from spraints was done using 21 autosomal markers (Lut435, Lut453, Lut604, Lut615, Lut701, Lut715, Lut717, Lut733, Lut782, Lut818, Lut832, Lut833 (Dallas and Piertney, 1998); Lut902 (Dallas et al., 1999); OT04, OT05, OT07, OT14, OT17, OT19, OT22 (Huang et al., 2005); RI18 (Beheler et al., 2005)). According to the multiple-tubes approach (Taberlet et al., 1996), we performed all multiplex polymerase chain reactions (PCRs) in triplicates. Sex determination was performed using 3 gonosomal markers (SRY (Dallas et al., 2000); DBY7Ggu (Hedmark et al., 2004); ZFX/Y (Mucci and Randi, 2007)). PCRs were carried out in a final volume of 10 µl containing 5 µl HotstarTaq master mix, 1 µl primer mix, 0.8 µl RNA-free water, 0.2 µl BSA, and 3 µl sample DNA. Thermal cycling conditions were as follows: 15 min at 95 °C, 41 PCR cycles with 30 s at 95 °C, 90 s at 58 °C, and 60 s at 72 °C with a final time of 30 min at 72 °C. In addition, we genotyped 40 tissue reference probes (16 from our study area, 8 from Austria, 8 from Bavaria, and 8 from the Czech Republic, all taken from the reference tissue database of the Senckenberg Research Institute, Gelnhausen, Germany) in a single-tube approach to construct a genotype reference panel for the collected spraint samples. Fragment analysis of PCR products was performed at the Senckenberg Biodiversity and Climate Research Centre (BiK-F), Frankfurt, Germany, using an ABI 3730 DNA Analyzer (Applied Biosystems). Allele calling was done using the software GENEMARKER v2.2 (SoftGenetics, State College, USA). Consensus genotypes, allelic dropout and false alleles rates were calculated using GIMLET (Valière, 2002). Individualization of samples was based on the consensus genotypes taking the genotyping error rate and result of the sex determination into account. Specifically, two samples were assigned to two individuals, if each of them had at least 50 % successfully genotyped markers, i.e., for at least 11 loci, and their genotypes differed in at least 3 loci. Ambiguous samples were excluded from further analysis. The probability of identity for unrelated individuals (PID) and for siblings (PID_{sib}) (Waits et al., 2001) was calculated using GenAlEx 6.5 (Peakall and Smouse, 2006; Peakall and Smouse, 2012) to assess whether the number of investigated and successfully genotyped loci is sufficient to separate two unrelated individuals and siblings from each other, respectively. The number of individual genotypes was hence taken as an estimate for the population size at the Spree and the Lusatian Neisse. We furthermore extrapolated the otter population size estimate for both rivers together by applying the rarefaction method (Kohn et al., 1999) using non-linear regression in *R* (R Core Team, 2018).

RESULTS

Activity Density

At the Spree and the Lusatian Neisse, 12 and 18 beaver territories could be identified, respectively. Further, 50 % of the sections of the smaller streams, which were only selectively sampled, also showed beaver activity. As to the otter, 77 % and 66 % of the surveyed sections at the Spree and the Lusatian Neisse, respectively, and 76 % of the surveyed sections of the smaller streams were otter-positive. This resulted in an average number of 6.5 ± 8.7 (standard deviation, SD) spraints for the Spree, 6.1 ± 6.8 for the Lusatian Neisse, and 7.3 ± 7.8 for all other streams.

The results of the exploratory analysis to identify habitat features and potential confounders relevant to colonization success and sign discovery are summarized in Table 4.

Table 4. Results of the exploratory correlation analysis of habitat features and potential confounders with otter activity density. *P* values of the variable-by-variable tests are reported with values in ***bold and italics*** indicating significant findings with $P \leq 0.05$. It is of note that due to the the few number of bridges in the survey area, the sum over bridges of different sprainting potential in a given river section was calculated yielding the total number of bridges per section. JTT: Jonckheere-Terpstra trend test (in the case of more than two groups); MWU: Mann-Whitney U test; HT: H test; SCT: Spearman correlation test; NA: Value not available (e.g. too few different observations); -: No Value available, because the variable was categorial. Effect direction of the MWU test is given as the difference in location for dichotomous (absent/present) variables, such that positive values correspond to more otter activity in the 'present' group compared to the 'absent' group. As to the SCT, the effect is given in terms of the correlation coefficient, such that positive values correspond to a higher otter activity with higher values of the respective variable. In the case of the JTT, the arrow pointing up- or downwards indicates the direction of relationship between the variable and otter activity for the underlying alternative hypothesis of the test statistic. As an example, 'more bridges' with an arrow pointing upwards means that the alternative hypothesis is defined as 'increasing otter activity with increasing number of bridges'.

		Spree		Lusatian Neisse		Other streams	
Variable	Test	Effect direction	p value	Effect direction	p value	Effect direction	p value
Stream nativeness	JTT	more natural↑	***0.022***	more natural↑	0.41	more natural↑	0.054
Bank nativeness	JTT	more natural↑	0.311	more natural↑	0.911	more natural↑	0.064
Structural features in water	JTT	more features↑	0.755	more features↑	0.096	more features↑	0.849
Shoreline stabilization	JTT	more natural↑	0.814	more natural↑	0.888	more natural↑	***0.027***
Riverine vegetation	JTT	more wood↑	0.886	more wood↑	0.725	more wood↑	0.287
Water quality score	JTT	better↑	0.81	better↑	0.637	better↑	0.257
Land use of surroundings	JTT	more extensive↑	0.776	more extensive↑	0.255	more extensive↑	***< 0.001***
Spatial coherence of habitat	JTT	more isolation↓	0.153	more isolation↓	0.992	more isolation↓	0.164
Food availability for the otter	JTT	more food↑	***0.019***	more food↑	NA	more food↑	***< 0.001***
Threat due to road traffic	JTT	more threat↓	0.56	more threat↓	NA	more threat↓	0.366
Human disturbance	JTT	more disturbance↓	***0.005***	more disturbance↓	0.951	more disturbance↓	0.118
River width	SCT	-0.331	***0.003***	-0.067	0.513	0.204	0.2
Shrub coverage	SCT	-0.107	0.343	-0.137	0.177	0.037	0.815
Humans	JTT	more humans↓	0.062	more humans↓	0.494	more humans↓	0.085
Domestic animals	JTT	more animals↓	0.272	more animals↓	0.242	more animals↓	0.076
Buildings	MWU	0	0.922	0	0.714	0	0.57
Standing water	MWU	-1	0.132	1	***0.030***	-3	***0.028***
Potential sprainting sites	MWU	-1	0.318	-8	***< 0.001***	1	0.58
Distance searched until first spraint discovery	SCT	-0.498	***< 0.001***	-0.413	***< 0.001***	-0.404	***0.025***
Anthropogenic damming structures	MWU	1	0.228	-3	0.148	-17	***< 0.001***
Number of bridges	JTT/MWU	more bridges↑	0.571	-2	0.216	more bridges↑	0.079
Weather	HT	-	0.164	-	***< 0.001***	-	0.053

The corresponding results of the correlation analysis of beaver presence signs with otter activity density can be found in Table 5. As a result, stream nativeness, shoreline stabilization, land use of surroundings, food availability for the otter, human disturbance, river width, standing water, potential sprainting sites, anthropogenic damming structures, and weather showed significant correlations with otter activity density for at least one river system (all $P \leq 0.05$, see Table 4). Moreover, the variable for the distance searched until first spraint discovery did not show a significant positive correlation with the habitat quality score (not shown), which would otherwise distort the ensuing analyses as explained in Romanowski et al. (1996) and Romanowski (2013). With regard to beaver signs, the most promising, albeit non-significant, results were obtained for weighted sums of fresh and old beaver tree cuts (Table 5).

Table 5. Results of the exploratory correlation analysis of presence signs of the beaver with otter activity density. Results of the variable-by-variable tests are reported with values in ***bold and italics*** indicating significant findings with *P*≤0.05. For more details see Table 4.

		Spree		Lusatian Neisse		Other streams	
Variable	Test	p value	Effect direction	p value	Effect direction	p value	Effect direction
Beaver presence	MWU	0.248	1	0.602	3	0.633	0
Weighted sum of fresh beaver tree cuts	SCT	0.11	-0.179	0.093	-0.171	0.857	0.029
Weighted sum of old beaver tree cuts	SCT	0.137	-0.167	0.097	-0.169	0.258	-0.18
Beaver runs	JTT	0.885	more runs ↑	0.642	more runs ↑	0.362	more runs ↑
Beaver footprints	MWU	0.817	0	0.15	-1	0.585	-3
Beaver buildings	MWU	0.358	3	0.773	0	0.24	2

According to the regression model selection using the basic model and the *BIC*, a negative binomial regression model was found to optimally fit the data and was hence used for the final analysis. Accordingly, the best-fitting model according to the *AIC* included the predefined fixed confounders (number of bridges, potential sprainting sites, presence of anthropogenic damming structures, river system, and weather), the weighted sum of fresh beaver cuts, and the variables stream nativeness and food availability for the otter (Table 6).

Table 6. Results of the negative binomial regression model with otter activity density as the primary outcome. *β*: regression coefficient; *exp(β)*: transformed regression coefficient to the linear scale, corresponding to the incidence risk ratio (IRR); CI: confidence interval; *n*: sample size. The Lusatian Neisse was used as the reference category for the river system variable; sunny weather was used as the reference category for the weather variable. Nagelkerke's r^2: goodness-of-fit measure (Nagelkerke, 1991).

Variable	β	95%-CI	$exp(\beta)$	95%-CI	p value
Intercept	0.559	-0.705; 1.83	1.75	0.494; 6.218	0.354
Spree	0.117	-0.333; 0.566	1.124	0.717; 1.762	0.591
Other streams	0.47	-0.076; 1.035	1.599	0.926; 2.815	***0.088***
Stream nativeness	0.332	0.078; 0.586	1.393	1.081; 1.796	***0.009***
Potential sprainting sites	0.834	0.3766; 1.3212	2.302	1.457; 3.748	$<$ ***0.001***
Number of bridges	0.11	-0.261; 0.498	1.117	0.771; 1.645	0.58
Bright weather	0.473	-0.37; 1.4	1.605	0.691; 4.041	0.264
Cloudy weather	0.257	-0.192; 0.695	1.293	0.825; 2.003	0.24
Rainy weather	0.835	0.27; 1.415	2.305	1.31; 4.117	***0.002***
Snowy weather	-0.057	-0.817; 0.723	0.945	0.442; 2.061	0.877
Food availability for the otter	-0.832	-1.339; -0.329	0.435	0.262; 0.72	$<$ ***0.001***
Anthropogenic damming structures	0.616	0.035; 1.243	1.852	1.036; 3.466	***0.04***
Weighted sum of fresh beaver tree cuts	-0.021	-0.038; -0.005	0.979	0.963; 0.995	***0.013***

$n = 220$, Nagelkerke's$r^2 = 0.39$

Among the potential confounders and habitat correlates, potential sprainting sites (*P*<0.001), anthropogenic damming structures (*P*=0.04), rainy weather (*P*=0.002), and stream nativeness (*P*=0.009) were significantly associated with otter activity density. The effect of beaver activity density on otter activity density according to the regression analysis is graphically displayed in Figure 2. As can be seen from Table 6, otter activity decreased by 2 % spraint for a unit increase in current beaver activity (*P*=0.013).

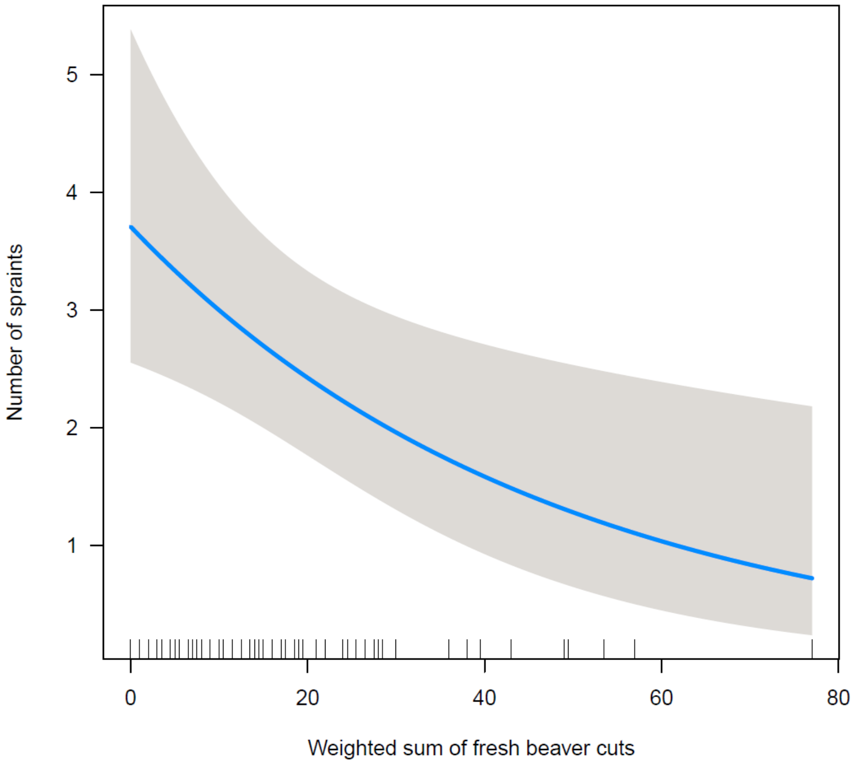

Figure 2. Graphical depiction of the effect of beaver activity on otter activity density according to the negative binomial regression model. The regression line corresponds to the model fit of the otter activity signs with all other variables set to their median value, plotted on the scale of the original response (see also Breheny and Burchett (2017)). Small vertical lines at the bottom depict actual data points for the weighted sum of fresh beaver cuts. The regression line is drawn in blue together with its corresponding 95 % confidence interval. The weighted sum of fresh beaver cuts was calculated, such that tree cuts of sizes 1, 2-5, and >5 were weighted (multiplied) with the constants 1, 3.5, and 10, respectively. The plot was drawn using the *R* package visreg (Breheny and Burchett, 2017).

The correlation analysis in four beaver territories and flanking areas can be found in Table 7.

Table 7. Results of the explorative correlation analysis of otter spraints with presence signs of the beaver in beaver territories. p_{adj}: corrected p value using the procedure by Benjamini and Hochberg (1995). Numbers in brackets indicate the predefined size classes of beaver cuts. CI: confidence interval. For more details see Table 4.

Variable	Test	Effect direction	95%-CI	p_{adj}
Weighted sum of fresh beaver tree cuts	SCT	0.176	-0.283; 0.59	0.678
Number of fresh beaver tree cuts (1)	SCT	-0.116	-0.623; 0.399	0.678
Number of fresh beaver tree cuts (2-5)	SCT	0.19	-0.313; 0.592	0.678
Number of fresh beaver tree cuts (> 5)	SCT	0.199	-0.258; 0.636	0.678
Beaver runs	JTT	more runs ↑	-	0.29
Beaver footprints	MWU	2	-8; 12	0.678
Beaver buidlings	MWU	-1	-10; 7	0.678
Beaver marks	MWU	-4	-12; 2	0.404

Interestingly, larger beaver cuts were associated with more otter spraints, whereas beaver marks were correlated with fewer spraints. However, none of the findings were statistically significant.

Activity patterns

In summary, 662 activities, i.e., land corridor traverses, of beavers and 266 activities of the otter were recorded. The corresponding distributions of activities as a function of daytime hour and month are shown in Figure 3.

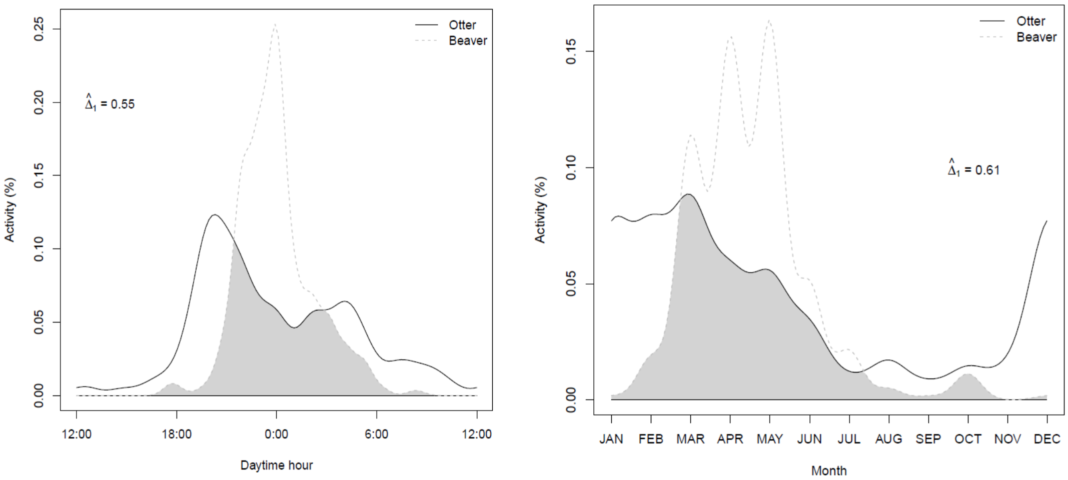

Figure 3. Overview of activity patterns for beavers and otters as a function of daytime hour (0-23, left subfigure) and month (January (JAN) to December (DEC), right subfigure). Data were collected using a camera trap monitoring a land corridor between the Spree and one of its abandoned meanders near Halbendorf (see also Figure 1). Kernel density estimates of the two species' activities are depicted with the area corresponding to the coefficient of overlap $\hat{\Delta}_1$ (Ridout and Linkie, 2009) shaded in grey. Plots were drawn using the *R* package overlap (Ridout and Linkie, 2009).

a

Beaver and otter activities were most numerous in spring between March and May, with an additional activity peak in December for the otter due to many traverses in 2015. With respect to daytime hour, beavers mostly traversed the corridor between 9 p.m. and 1 a.m., whereas otters were most frequently recorded between 7 p.m. and 10 p.m. and between 2 a.m. and 5 a.m. The differences in activity patterns subject to daytime hour and month were both significant (both $P<0.0001$), which might indicate temporal segregation of the two species ashore.

Species Identification

According to the analyzed mtDNA control region of the otter, all spraint samples (n=150) could be successfully assigned to *L. lutra*, all with mtDNA haplotype 7/8 according to Mucci et al. (2010), which was in line with previous findings for the study area (Mucci et al., 2010).

Population Sizes

Beaver

For the Spree, 20 activity centres with a median length of 450 m were recorded, corresponding to 12 beaver territories, including 5 family and 7 single/couple territories. For the Lusatian Neisse, 36 activity centres with a median length of 775 m were recorded, corresponding to 15 family and 3 single/couple territories. This corresponds to 0.9 and 1.4 individuals per km river section for the Spree and the Lusatian Neisse, respectively.

Otter

The genotyping results of the otter samples can be found in Table 8. Three samples were excluded from further analysis due to multiple triallelic loci during allele calling. From the remaining 147 samples, 93 samples could be assigned to a genotype of at least 11 autosomal loci.

Table 8. Genotyping success rate (GS), PCR success rate (PCR-S), allelic dropout rate (ADO), and false alleles rate (FA) for otter samples of different types. * Number of PCR reactions=147 samples x 3 replicates x 21 autosomal loci.

Sample type	GS ($n = 150$)	PCR-S ($n = 9261^*$)	ADO ($n = 93$)	FA (n = 93)
Jelly	0.78 ($n = 49$)	0.68 ($n = 2961$)	0.18 ($n = 38$)	0.0 ($n = 38$)
Spraint	0.56 ($n = 93$)	0.49 ($n = 5796$)	0.25 ($n = 52$)	0.0 ($n = 52$)
Mucus	0.38 ($n = 8$)	0.3 ($n = 504$)	0.25 ($n = 3$)	0.0 ($n = 3$)

An overview of the genotyped markers and the corresponding *PID* and PID_{sib} are depicted in Table 9.

Table 9. Overview of the autosomal microsatellite markers used for genotyping otter spraint samples, which resulted in 57 individuals. *N*: number of successfully genotyped individuals for a given marker; N_a: number of alleles; N_e: effective number of alleles, i.e., $1/\sum_i p_i^2$, with p_i the frequency of the *i*-th allele at a given locus; H_o: observerd heterozygosity, i.e., number of observed heterozygous genotypes / total number of observed genotypes; H_e: expected heterozygosity, i.e., $1-\sum_i p_i^2$, with p_i the frequency of the *i*-th allele at a given locus; F_{IS}: inbreeding coefficient calculated as $1-H_o/H_e$; *PID*: probability of identity for genotypes of two unrelated individuals and PID_{sibs}: probability of identity for genotypes of siblings, both calculated according to Waits et al. (2001).

Marker name	OT07	OT14	Lut733	Lut832	OT17	Lut902	Lut701	Lut717	Lut833	Lut435	OT04
N	54	57	51	55	52	55	43	46	55	54	53
N_a	8	5	5	5	4	2	4	6	4	5	4
N_e	2.82	2.212	3.299	2.441	3.057	1.037	1.439	4.64	2.923	2.819	2.407
H_o	0.611	0.544	0.686	0.473	0.519	0.036	0.163	0.587	0.527	0.63	0.509
H_e	0.645	0.548	0.697	0.59	0.673	0.036	0.305	0.784	0.658	0.645	0.585
F_{IS}	0.053	0.007	0.015	0.199	0.228	-0.019	0.466	0.252	0.198	0.024	0.129
PID	0.156	0.24	0.138	0.243	0.168	0.931	0.501	0.079	0.188	0.175	0.24
PID_{sibs}	0.466	0.536	0.436	0.516	0.456	0.965	0.723	0.377	0.468	0.471	0.518

	Lut818	Lut604	Lut782	Lut615	Lut715	RI18	OT19	OT22	Lut453	OT05	All loci (SE)
N	48	55	49	40	43	51	49	54	54	55	51.095 (1.033)
N_a	5	5	4	6	4	2	6	4	6	4	4.667 (0.295)
N_e	3.207	3.13	1.98	3.717	1.966	1.821	2.34	1.817	2.301	2.9	2.584 (0.177)
H_o	0.479	0.6	0.367	0.6	0.256	0.333	0.306	0.241	0.611	0.509	0.457 (0.038)
H_e	0.688	0.68	0.495	0.731	0.491	0.451	0.573	0.45	0.566	0.655	0.569 (0.036)
F_{IS}	0.304	0.118	0.258	0.179	0.479	0.261	0.465	0.465	-0.081	0.223	0.201 (0.037)
PID	0.15	0.158	0.322	0.103	0.295	0.403	0.214	0.346	0.28	0.185	< 0.0001
PID_{sibs}	0.443	0.449	0.583	0.41	0.578	0.625	0.517	0.612	0.537	0.469	< 0.0001

Accordingly, the probabilities for two unrelated individuals (*PID*) and siblings (PID_{sib}) having the same genotype, respectively, were lower than 0.0001 (see Table 9). The individualization resulted in 57 individuals with 26 (11 males, 14 females, 1 unknown gender) otters at the Spree and 31 (11 males, 15 females, 5 unknown gender) at the Lusatian Neisse. The corresponding otter densities hence were 0.54 otters/km and 0.53 otters/km at the Spree and the Lusatian Neisse, respectively. The extrapolated otter population density using the rarefaction method resulted in 157 otters (1.46 otters per km) for both rivers together (see Figure 4).

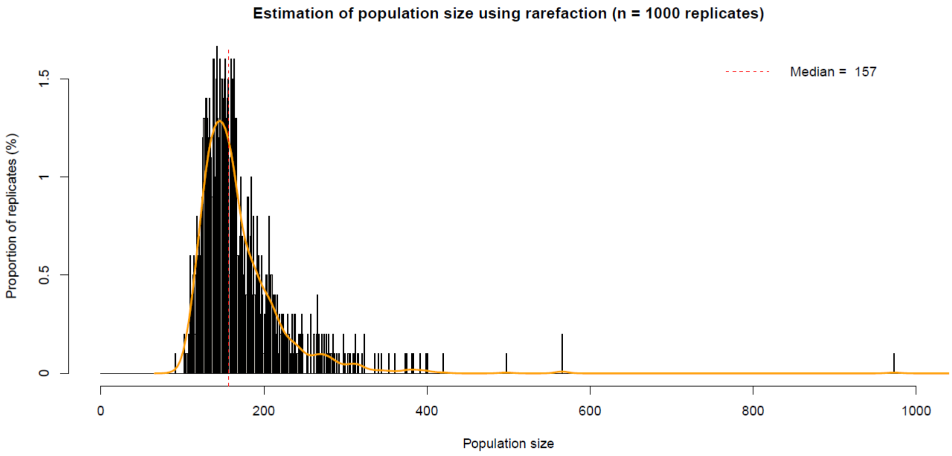

Figure 4. Extrapolation of the otter population size of the Spree and the Lusatian Neisse using the rarefaction method (Kohn et al., 1999). The kernel density estimate is shown in orange.

DISCUSSION

In this work, we tried to evaluate the interaction between Eurasian beavers and otters by comparing activity density estimates using correlation analysis and complex regression modelling, including potential confounders for habitat selection and species detectability. The beaver activity density estimate was calculated as a weighted sum of either fresh or old tree cuts per investigated river section. In the case of the otter, the activity density estimate was calculated as the number of spraints collected per investigated river section (Almeida et al., 2013). The suitability of counting otter spraints to estimate population sizes is under debate (Kruuk et al., 1986), but, in accordance with Almeida et al. (2013), we strongly believe that at least semi-quantitative measurements of otter activity are feasible.

In order to correctly model the effect of beaver activity on otter activity, potential confounders for otter habitat selection and detectability need to be identified. Critical habitat correlates for otter colonization in an anthropogenic environment are current matters of intensive debate (Romanowski et al., 2013). Evidence emerges that otters gradually colonize suboptimal habitats due to overpopulation in adjacent optimal primary habitats (Baltrūnaitė et al., 2009; Clavero et al., 2010; Romanowski et al., 2013). Critical factors favouring otter colonization of suboptimal anthropogenic habitats have only partly been identified and obviously strongly depend on the geographic region under study. Previous works suggest that otter abundance might be positively correlated with river width and depth in Poland (Romanowski et al., 2013). In addition, some works suggest a positive correlation between otter abundance and the availability of suitable holts and shrub coverage in Ireland (Ottino and Giller, 2004) as well as unregulated rivers in Poland (Romanowski et al., 2013). However, other works could not confirm a correlation between otter abundance and availability of holts in Poland (Romanowski, 2013), shrub coverage in Poland (Romanowski, 2013; Romanowski et al., 2013) and Great Britain (Kruuk et al., 1998), and unregulated rivers in Lithuania (Baltrūnaitė et al., 2009). A negative correlation between otter abundance and the presence of buildings was found in Lithuania (Baltrūnaitė et al., 2009) and South-East Poland (Brzeziński and Romanowski, 2006), but not in Central Poland (Romanowski et al., 2013). In addition, confounders influencing the probability to detect otter activity signs need to be identified and included in the regression analysis as well. Confounders for the detection probability of otter spraints might include the number of suitable sprainting sites (e.g. trees, stones, and sandbanks) (Romanowski et al., 2013), bridges (Romanowski, 2013), the presence of humans and domestic animals (Romanowski, 2013), and the presence of standing water nearby the riverside.

In the present study, we investigated a comprehensive set of potential confounders known from the literature, because most of their effects seem to be region-specific and hence have to be established anew for every other region (Romanowski et al., 2013). According to the results of our exploratory correlation analyses in Table 4, river width was negatively correlated with otter activity at the Spree (P=0.003), which was in line with Sidorovich et al. (1996), and might be due to the fact that otter abundance is linked to the relative fish biomass, which in turn is inversely proportional to river width (Schager and Peter, 2001). We also found human disturbance, i.e., mostly fishing and recreational use, to be negatively correlated with otter activity at the Spree (P=0.005). With regard to the regression analysis, only the variables stream nativeness and food availability were significantly and positively associated with higher otter activity density in addition to method-specific confounders, such as the availability of potential sprainting sites, presence of anthropogenic damming structures, smaller river systems, and rainy weather (see Table 6). The lack of other significant habitat features may be interpreted as a result of the otter's high adaptive potential that allows for the colonization of “suboptimal”, i.e., human-altered, habitats (Reid et al., 2013). Furthermore, rainy weather significantly increased the detectability of otter signs, probably due to the absence of low sun and hence better lighting conditions for finding spraints (P=0.002). In this context, it is of note that there was no substantial change of water levels during the study period, which could otherwise lead to washouts of spraints and consequently to reduced activity estimates. With respect to the impact of beaver activity, otter activity density decreased by 2 % per unit increase in fresh beaver cuts (P=0.013) (see Table 6). The correlation analysis of otter activity density as a function of beaver-related activity signs in beaver territories and flanking regions did not show any significant result, probably because of the small sample size (see Table 7). Hence, one may conclude that otter activity density is affected by a few habitat features and confounders and only slightly depends on beaver activity. Due to the little building activity of the beaver in our study area (only 3 minor dams), which seems to be more crucial when rivers are not sufficiently deep and wide (Harthun, 1999; Herr and Rosell, 2004), the presumed positive effect of beaver ponds for otters was absent. Beavers might also avoid otter activity centres to reduce the possibility of harmful encounters and hence increase protection of pubs from the otter as a potential agonist (Gallant and Sheldon, 2008).

As can be deduced from the results gained from the analysis of activity patterns using a camera trap, the possibility of direct encounters of beavers and otters ashore is reduced due to their different daytime hour preferences and the lowered activity density of the beaver during winter. However, due to the fact that we only had data for a single camera trap, this finding is of limited value and would need to be verified using a larger number of cameras and different land corridors.

A drawback of the field survey method applied in this study is that otter activity signs may have a reduced lifetime in beaver activity centres due to the high degree of beaver locomotion on runs, which are potential otter sprainting sites. This could lead to a reduced otter activity density estimate in beaver activity centres causing the observed inversely proportional relationship between beaver and otter activity. In addition, estimated activity densities of the present study were only based on surveys in autumn and winter, which, however, is the period showing the highest sprainting activity of otters in other studies (Conroy and French, 1987; Macdonald and Mason, 1987; Kruuk, 1992). In contrast, quantitative collection of otter spraints during the growing season is unfeasible. Further, more longitudinal data and camera traps are needed to validate and generalize the findings of the present study.

Despite the above-mentioned limitations, the study region was well-suited for such a quantitative correlation analysis, which was underpinned by population size estimates for the Spree and the Lusatian Neisse for both beavers and otters. The estimated density of 0.9 and 1.4 beavers per river km for the Spree and the Lusatian Neisse, respectively, corresponded well to the numbers given in Djoshkin and Safonow (1972) for suboptimal habitats (0.7-2.4). The estimated otter population size based on DNA fingerprinting and rarefaction of 1.46 otters per river km was comparatively high (see Lampa et al. (2015)), but still plausible in regard to the outstanding significance of the otter population in our study area (Ansorge, 1994). Furthermore, the study period shows the lowest otter birth rate in the study area, thus ruling out additional underrepresentation of female scats in the sample (Hauer et al., 2002; Lampa et al., 2015), and it is the time when otters increasingly appear at streams due to drained fishery ponds in winter (Lampa et al., 2015). The otter population size presented in this work, however, should be interpreted as a rough estimate, because DNA fingerprinting methods for otters are extremely error-prone and demand even more samples and replications than we were able to perform to validate the results (Lampa et al., 2015).

In summary, the results of the field survey data indicated that otter activity was only slightly influenced by beaver activity. This might be due to the fact that the study area, with a long history of pond fisheries, already provides optimal otter hunting grounds. In turn, beavers did not show a pronounced building activity, probably because the rivers Spree and Lusatian Neisse are sufficiently deep and wide to facilitate colonization. We were able to demonstrate that beavers and otters mainly traverse a land corridor at different daytime hours during the night. In contrast to beavers, otter activity ashore was high during winter. This was probably due to a spatial reorganization of pond and river home ranges with an increasing number of otters foraging in river habitats due to winter draining of fish ponds. According to our population size estimates, the study area is densely populated by otters, whereas the beaver population size indicated suboptimal habitat conditions.

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RESUME

INFLUENCE DU CASTOR EURASIEN (*Castor fiber*) SUR LA LOUTRE EURASIENNE (*Lutra lutra*) ÉVALUÉE PAR ESTIMATION DE LA DENSITÉ D'ACTIVITÉ DANS DES HABITATS ANTHROPOGENIQUES DE L'EST DE L'ALLEMAGNE

Les espèces de mammifères semi-aquatiques comme le Castor eurasien *Castor fiber* (LINNAEUS, 1758) et la loutre eurasienne *Lutra lutra* (LINNAEUS, 1758) se retrouvent simultanément dans les écosystèmes européens d'eau douce. La connaissance de l'interaction entre les deux espèces peut être utile pour prédire la distribution et la colonisation des espèces. La présente étude compare les densités d'activité des castors et des loutres durant la saison hivernale 2015/2016 dans des habitats anthropiques de l'est de l'Allemagne. L'activité du castor a été évaluée à l'aide des arbres coupés, l'activité de la loutre à l'aide d'épreintes. Les résultats ont indiqué que l'activité des loutres n'était que légèrement influencée par l'activité des castors (2% d'activité des loutres en moins pour une augmentation unitaire de l'activité des castors, P = 0,013), probablement parce que la zone d'étude fournit déjà des terrains de chasse optimaux en terme d'approvisionnement en poisson pour la loutre. . Des résultats supplémentaires obtenus à partir des données bisannuelles des pièges photographiques, recueillis entre 2015 et 2017, ont indiqué une ségrégation temporelle des deux espèces en période d'étiage (P <0,0001). Selon nos estimations de la taille de la population de loutres à l'aide de marqueurs d'ADN microsatellites et de raréfaction, la zone d'étude est densément peuplée en loutres (1,46 loutre par km de berge), tandis que la taille de la population de castors, basée sur l'identification des territoires, indiquait des conditions d'habitat sous-optimales (1,15 castor par km de berge).

RESUMEN

INFLUENCIA DEL CASTOR EUROPEO (*Castor fiber*) EN LA NUTRIA EURASIÁTICA (*Lutra lutra*), EVALUADA MEDIANTE ESTIMACIONES DE DENSIDAD DE ACTIVIDAD EN HABITATS ANTROPOGÉNICOS EN EL ESTE DE ALEMANIA

Las especies de mamíferos semiacuáticos Castor Europeo *Castor fiber* LINNAEUS, 1758, y la nutria Europea *Lutra lutra* (LINNAEUS, 1758) ocurren simultáneamente en ecosistemas europeos de agua dulce. El conocimiento sobre sus interacciones mutuas puede ser útil para predecir las distribuciones y colonización de ambas especies. Este estudio compara las densidades de actividad de castore y nutrias durante el invierno 2015/2016, en hábitats antropogénicos en el este de Alemania. La actividad de los castores fue evaluada mediante cortes de árboles, y la de las nutrias mediante fecas. Los resultados indicaron que la actividad de las nutrias estuvo influida sólo levemente por la activida de los castores (2 % menos de actividad de nutrias por cada unidad de incremento de la actividad de castores, P=0.013), probablemente porque el área de estudio ya proporciona espacios de cacería óptimos en términos de provisión de peces para las nutrias. Resultados adicionales obtenidos de datos bianuales de cámaras-trampa, entre 2015 y 2017, apuntan a una segregación temporal de ambas especies durante los períodos de aguas bajas (P<0.0001). De acuerdo a nuestras estimaciones de tamaño poblacional de nutrias usando marcadores y rarefacción de microsatélites de ADN, el área de estudio está densamente poblada de nutrias (1.46 nutrias por km de costa de río), mientras que el tamaño poblacional de castores, basado en identificación de territorios, indicó condiciones subóptimas de hábitat (1.15 castores por km de costa).

R E P O R T

OPPORTUNISTIC SMOOTH-COATED OTTER (*Lutrogale perspicillata*) SIGHTINGS RECORD IN THE BARDIYA NATIONAL PARK OF NEPAL

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ABSTRACT: The Smooth-coated otter *Lutrogale perspicillata* is one among three species of otters found in Nepal. Although *L. perspicillata* has been classified as 'Endangered' nationally, there is a serious lack of information on various aspects of its natural history in Nepal including the Bardiya National Park (NP). We surveyed 118 km of the Karnali and Babai rivers from February 3-13, 2017 to record opportunistic sightings of *L. perspicillata* and its behaviour in the Bardiya NP. We directly sighted a total of 27 individuals of *L. perspicillata* including 14 in the Karnali and 13 in the Babai with relative densities of and 0.23/km in the Karnali and 0.22/km in Babai. Similarly, we also observed interspecific interaction between a large group of *L. perspicillata* and Mugger crocodile (*Crocodylus palustris*) in the eastern channel of the Karnali. The 46 km stretch of Babai and 30 km stretch of the Karnali river (eastern channel also referred to as Geruwa) within the jurisdiction of the core-protected area of the Bardiya NP has habitat only little modified and with relatively low anthropogenic disturbances owing to stringent protection level, and could be crucial to ensure long-term conservation of *L. perspicillata* in and around the Bardiya NP. Our findings establish a good preliminary baseline for *L. perspicillata* populations in the Bardiya NP and importantly for the Babai.

Keywords: Otter, Karnali River, Babai River, Gharial, Mugger crocodile

INTRODUCTION

Nepal is home to three species of otter, the Eurasian otter *Lutra lutra*, the Asian small-clawed otter *Aonyx cinereus* and the Smooth-coated otter *Lutrogale perspicillata* (Kafle, 2009). The Smooth-coated otter (Figure 1) is classified as "Vulnerable" in the IUCN Red List and as an "Endangered" species in Nepal (Jnawali et al., 2011). Approximately 200-1000 *L. perspicillata* are estimated to occur in Nepal and its population is speculated to be declining (Kafle, 2009; Jnawali et al., 2011). The main threats to *L. perspicillata* and its habitat are believed to be habitat destruction and alteration including change in river morphology, poaching, entanglement and death in fishing nets and construction of dams (Kafle, 2009; Jnawali et al., 2011).

Figure 1. A group of Smooth-coated otter *Lutrogale perspicillata* at Teen kune in the Bardia National Park, Nepal (Photo credit: Ashish Bashyal; Date: February 13, 2017)

Although *L. perspicillata* is "Endangered" nationally, it is rather surprising that there is a serious lack of information on various aspects of its natural history in Nepal (Kafle, 2009; Acharya and Lamsal, 2010; Jnawali et al., 2011). In fact, throughout its range in Nepal, spatial distribution, population size, habitat preference etc. of *L. perspicillata* remain poorly understood as there have been few detailed studies on this species in the country (Kafle, 2009; Jnawali et al., 2011). The Government of Nepal, Department of National Parks and Wildlife Conservation has prepared action plans for major priority species but *L. perspicillata* is under shadow because to date there have been only limited scientific studies. Consequently, there is no action plan in place for *L. perspicillata*, thus further exacerbating its already perilous situation. Given the range-wide threats that *L. perspicillata* faces, stretches of rivers within the jurisdiction of protected areas could serve as a refuge to its dwindling populations. One such protected area which could be a critical refuge to *L. perspicillata* in Nepal is the Bardiya National Park (Bardiya NP; Figure 2). The Bardiya NP is drained by two perennial rivers (Karnali and Babai) which are home to gharial *Gavialis gangeticus*, Marsh crocodile *Crocodylus palustris*, Gangetic dolphin *Platanista gangetica* and *L. perspicillata* among others. Although some studies on *L. perspicillata* have been done in certain stretches of Karnali (Thapa, 2002; Bhandari, 2008; Joshi, 2009), there has been only one study (Bhandari, 2019) on this species in the Babai.

As a part of the Nepal Gharial Conservation Initiative, a long-term project aimed at safeguarding future of gharial populations in Nepal, we studied population and habitat ecology of gharials in the rivers of the Bardiya NP in 2017. During the course of this survey, we also recorded opportunistic sighting of *L. perspicillata*, its behaviour and interaction with Mugger crocodile throughout 118 km of Karnali and Babai rivers in the Babai of the Bardiya NP.

METHODS
Study Area

This study was conducted in sections of two rivers (Babai and Karnali) in Bardiya NP (28°15' to 28°35.5' N and 80°10' to 81°45' E; Figure 2). The Bardiya NP is situated in Bardiya district of Province-5 in south-western Nepal and covers an area of 968 square kilometers. The Bardiya NP is drained by two major rivers: the Karnali in the west and the Babai in the east (Bhuju et al., 2007). The Babai enters Bardiya NP from its north-eastern boundary and exits at Parewaodar approximately 46 km downstream. Similalry, the Karnali enters the Bardiya NP from its north-western boundary and bifurcates into two major channels downstream. A 60 kilometer (km) stretch of the Karnali River (comprising of 30 km strech within the protected area and 30 km stretch in the buffer zone) and a 58 km stretch of the Babai River (comprising of 46 km stretch in the protected area and 12 km in the buffer zone) were surveyed accordingly.

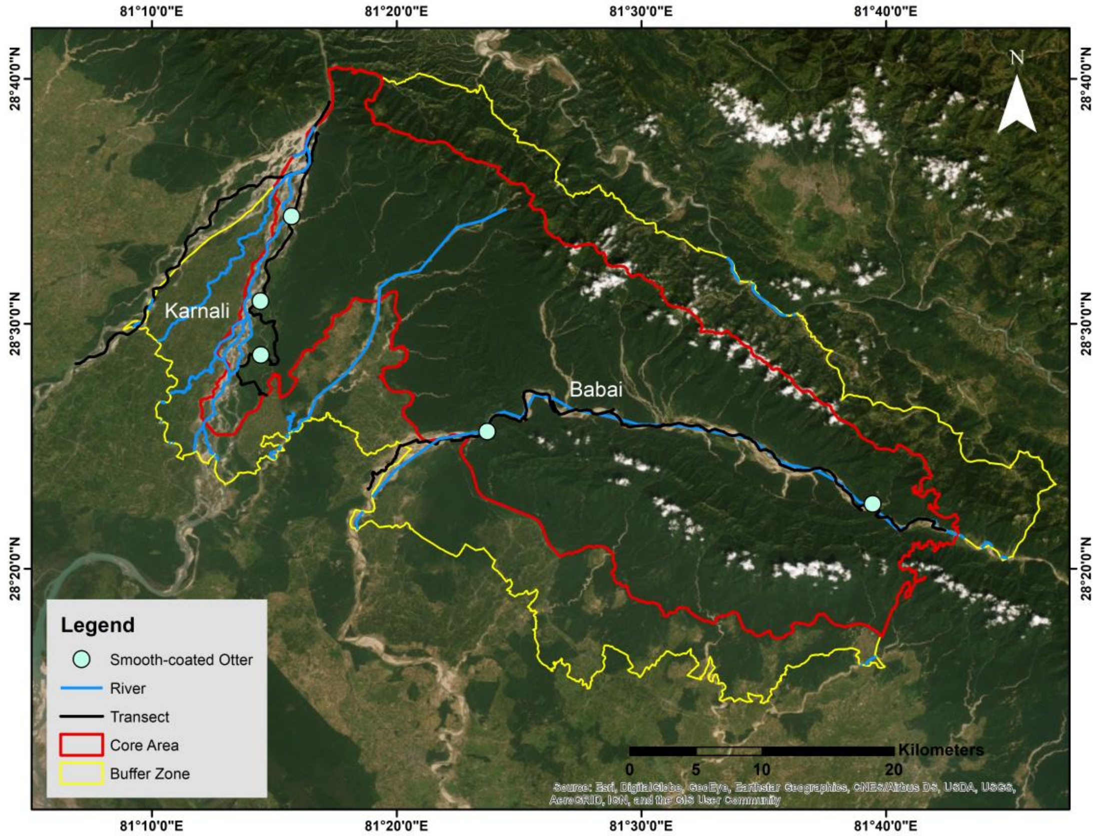

Figure 2. Map showing sighting localities of the Smooth-coated otter *Lutrogale perspicillata* in Bardiya National Park, Nepal

Opportunistic survey

From February 3-13, 2017, we surveyed a total of 118 km of the Karnali and Babai rivers. Surveys were conducted during day time (8:00 to 16:00 hour local time) by walking downstream along river banks. Occasionally, stationary surveys were also conducted from vantage points. River and banks were thoroughly searched for *L. perspicillata* on either bank with binoculars (Celestron Nature DX 8x42, Celestron, USA). Photographs of encountered *L. perspicillata* were taken with a Nikon 55-300 millimetre telephoto zoom lens attached to Nikon D3100 DSLR camera (Nikon Corporation, USA) and GPS (Global Positioning System) co-ordinates were recorded for each individual or a group of *L. perspicillata* using a hand-held GPS device

(Garmin GPSmap64). Habitats where otters were encountered were classified into four categories (sand bank, clay bank, sand-grass bank and rocky bank) by modifying the classification scheme for gharial habitat in Narayani river of Nepal described by Maskey et al. (1995). Whenever possible, we observed *L. perspicillata* behaviour and interspecific interaction between *L. perspicillata* and other sympatric top predators.

RESULTS AND DISCUSSIONS

In a total of 118 km of the Karnali and Babai rivers, we directly sighted a total of 27 *L. perspicillata* (Table 1) of which 13 individuals in the Babai and 14 in the Karnali. We did not take any measure to eliminate/address possibility of repeat sightings of the same individual and it is possible that our total count might actually involve fewer than 27 individuals. We did not observe or suspect any other species of otter during our surveys. The relative densities of *L. perspicillata* were 0.22/km in Babai and 0.23/km in the Karnali. *Lutrogale perspicillata* was sighted in five different localities comprising two in the Babai and three in Karnali (Figure 2). The largest group of *L. perspicillata* which included 12 individuals was recorded in Teen kune where the animals were observed feeding and grooming on the sand bank. Two groups of otters comprising of 21 individuals were observed grooming whereas others were observed swimming (Table 1). Grooming behaviour was self-grooming which consisted of rolling on sandy bank with intermittent dips in water and drying by rolling (Hussain, 2013). This range of behaviour exhibited by otters probably is related to habitat type. For instance, two out of five groups that showed grooming behaviour were observed by the sand bank whereas the other three groups, that were swimming, were observed near rocky bank habitat.

Table 1: Opportunistic sightings record of Smooth-coated otter *Lutrogale perspicillata* in the Bardiya National Park

Site	River	Number of encounters	Total otter count	Habitat type	Activity	
					Grooming	Swimming
Soth Khola	Babai	1	9	Sand bank	9	0
Parewaodar	Babai	1	4	Rocky bank	0	4
Lalmati	Karnali	1	1	Rocky bank	0	1
Gaid Machan	Karnali	1	1	Rocky bank	0	1
Teen Kune	Karnali	1	12	Sand bank	12	0
Total		5	27		21	6

Thapa (2002) estimated a density of 1 individual per km for *L. perspicillata* in a 35 km stretch of the Geruwa. Similarly, Bhandari (2008) estimated 40 *L. perspicillata* present in 1.98 square kilometres in the Karnali based on spraint count alone. Joshi (2009) studied the population of *L. perspicillata* in an unprotected stretch of the Karnali and suggested that indirect signs were mostly observed in undisturbed habitat, but their study did not provide any quantitative data on abundance or density of *L. perspicillata* signs. Similarly, Bhandari (2019) only mapped the potential distribution of *L. perspicillata* in 46 km stretch of the Babai based on the presence/absence of indirect signs but did not estimate its density. Since all of these studies including ours have adopted different methodologies to estimate *L. perspicillata* density/abundance, direct comparisons of estimates of *L. perspicillata* distribution might reflect as much about methodological differences as about real density differences.

Furthermore, all 27 *L. perspicillata* observed were within the jurisdiction of the Bardiya NP (classified as core protected area). None was observed in the 42 km of these rivers within the buffer zone which has less stringent protection level and much higher prevalence of threats than does the core protected area. Our observations indicate that major threats to *L. perspicillata* and its habitat appeared to be the destruction and modification of riverine habitats, sand mining, boulder quarrying and unlicensed fishing.

Smooth-coated otter is sympatric with the gharial and Mugger crocodile, two other top predators in the freshwater ecosystem of the Karnali and Babai rivers. We observed large group of *L. perspicillata* comprising of 12 individuals chasing around an adult Mugger crocodile in Teen kune (Figure 3). Teen kune is characterized by its sand bank and deep water pool and is seemingly preferred habitat by both of these species. We did not observe any interspecific interaction between *L. perspicillata* and gharials during the survey. Nonetheless, there seemed to be more signs of *L. perspicillata* such as foot track, tail drag marks and spraints in localities where gharials were seen than in localities where they were not, although this was not confirmed by systematic counting. Gharials are known to prefer sand banks for basking and deep water pools with higher fish abundance; and they feed primarily on fishes (Stevenson and Whitaker, 2010). The smooth-coated otter also feeds primarily on fish and prefers sandy banks for grooming activities (Hussain and Choudhury, 1998; Nawab and Hussain, 2012b). Such overlap in diet and behaviour suggests that probably there is some overlap in habitat preference and use in between otters and gharials. However, detailed study is warranted to clarify such speculation.

Figure 3. A group of Smooth-coated otters (*Lutrogale perspicillata*) chasing away adult mugger crocodile (*Crocodylus palustris*) at Teen kune in the Bardiya National Park, Nepal (Photo credit: Ashish Bashyal; Date: February 13, 2017)

Herein, we presented our findings on opportunistic sightings of *L. perspicillata* in the Karnali and Babai rivers in the Bardiya NP. Although some prior information on *L. perspicillata* is available from Karnali, there had been no previous attempt to study relative abundance or density of *L. perspicillata* in the Babai. Our findings establish a good preliminary baseline for *L. perspicillata* populations in the Bardiya NP and importantly for the Babai. Our survey wasn't primarily targeted at *L. perspicillata* and we did not take any measures to avoid repeated counting of the same individual. Nonetheless, our results could be compared to that of future studies with similar methodologies to approximately assess the change in density of *L. perspicillata* in the Karnali and Babai rivers in the Bardiya NP. The 46 km stretch of the Babai and 30 km stretch of the Karnali river (eastern channel also referred to as Geruwa) within the jurisdiction of the core-protected area of the Bardiya NP have very little anthropogenic disturbance and have habitat only little modified that holds *L. perspicillata*. It is therefore likely to be of particular importance for the species' conservation in and around Bardiya NP. Long-term survival of *L. perspicillata* would benefit from the design and implementation of science-based conservation strategy based on information generated from scientific studies, which unfortunately are largely lacking for *L. perspicillata* in the Bardiya NP. It is urgent to conduct systematic survey to understand threats to *L. perspicillata* and their drivers so that strategies effective in their mitigation can be generated and implemented.

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RESUME

REGISTRE DES OBSERVATIONS OPPORTUNISTES DE LA LOUTRE A PELAGE LISSE (*Lutrogale perspicillata*) DANS LE PARC NATIONAL DU BARDIYA AU NÉPAL

La loutre à pelage lisse *Lutrogale perspicillata* est l'une des trois espèces de loutres présentes au Népal. Bien que *L. perspicillata* ait été classée comme «en voie de disparition» à l'échelle nationale, il existe un sérieux manque d'informations sur divers aspects de son histoire naturelle au Népal, en ce compris le parc national de Bardiya (NP). Nous avons inspecté 118 km des rivières Karnali et Babai du 3 au 13 février 2017 pour enregistrer des observations opportunistes de *L. perspicillata* et son comportement dans le PN de Bardiya. Nous avons directement observé un total de 27 individus de *L. perspicillata* dont 14 dans le Karnali et 13 dans le Babai avec des densités relatives de 0,23 / km dans le Karnali et 0,22 / km dans le Babai. De même, nous avons également observé une interaction interspécifique entre un grand groupe de *L. perspicillata* et le crocodile de Mugger (*Crocodylus palustris*) dans le canal oriental du Karnali. Les tronçons rivière de 46 km du Babai et de 30 km du Karnali (canal oriental également appelé Geruwa) situés dans la juridiction de l'aire protégée centrale du PN de Bardiya ont un habitat peu modifié avec des perturbations anthropiques relativement faibles en raison du niveau de protection rigoureux. Ils pourraient être cruciaux pour assurer la conservation à long terme de *L. perspicillat*a dans et autour du PN de Bardiya. Nos résultats établissent une bonne base de référence préliminaire pour les populations de *L. perspicillata* dans le PN de Bardiya et surtout pour le Babai.

RESUMEN

REGISTRO DE AVISTAJES OPORTUNÍSTICOS DE NUTRIA LISA (*Lutrogale perspicillata*) EN EL PARQUE NACIONAL BARDIYA, NEPAL

La nutria lisa *Lutrogale perspicillata* es una de las tres especies de nutria de Nepal. Aunque *L. perspicillata* ha sido clasificada nacionalmente como "En Peligro de Extinción", hay una seria falta de información sobre varios aspectos de su historia natural en Nepal, incluyendo al Parque Nacional (PN) Bardiya. Relevamos 118 km de los ríos Karnali y Babai, entre el 3 y el 13 de Febrero de 2017, para registrar avistajes oportunísticos de *L. persicillata*, y su comportamiento, en el PN Bardiya. Avistamos en forma direta un total de 27 individuos de *L. perspicillata*, incluyendo 14 en karnali y 13 en Babai, con densidades rrelativas de 0.23/km en Karnali y 0.22/km en Babi. En forma similar, también observamos interacciones interespecíicas entre un gran grupo de *L. perspicillata* y un cocodrilo de las marismas (*Crocodylus palustris*) en el canal oriental del Karnali. Los 46 km del río Babi y los 30 km del río Karnali (el canal oriental también conocido como Geruwa) dentro de la jurisdicción del área protegida núcleo del PN Bardiya, tiene hábitat modificado sólo ligeramente, y con disturbios antrópicos relativamente bajos, debido al estricto nivel de protección, y podrían ser cruciales para segurar la conservación a largo plazo de *L. perspicillata* en y alrededor del PN Bardiya. Nuestros hallazgos establecen una buena línea de base preliminar de las poblaciones de *L. perspicillata* en el PN Bardiya, y de manera importante para el Babai.

SYMPOSIUM REPORT

IMPLICATIONS OF THE NEW MANDATORY REGISTRATION SYSTEM FOR CAPTIVE ASIAN SMALL-CLAWED OTTERS (*Aonyx cinereus*) IN JAPAN

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Abstract: The Asian Otter Conservation Society of Japan (AOCSJ) was established by Japanese otter researchers on October 1st, 2019 to boost conservation activities affecting otters. Illegal trade of captive Asian small-clawed otters is one of the most serious animal welfare problems in Japan and a new regulation system for this species started on November 26th, as a result of the change in CITES Appendices rank from II to I in August, 2019. To educate the public about this, and to discuss it with them, a symposium was held by the AOCSJ on November 3rd, 2019. At this symposium, four presentations and a panel discussion were shared with an audience of 55 people, including several media journalists. Important points from these presentations were 1) several behaviors of owners including renting, borrowing, giving and receiving otters will be regulated under the Law for the Conservation of Endangered Species of Wild Fauna and Flora (LCES), not only buying and selling; 2) the registration number, registration date and expired date will be needed when selling Asian small-clawed otters based on LCES; 3) stricter rules and publicity should be applied to this registration, and clear rules are necessary to make sure only legally held individual otters can be registered in the future. AOCSJ will continue working to raise awareness and facilitate public behavior changes with regard to otters, to support more effective conservation of wild populations by reducing, and we hope to remove the pressure from the Japanese pet trade on Asian small-clawed otters.
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INTRODUCTION

On October 1st, 2019, the Asian Otter Conservation Society of Japan (AOCSJ) was established by Japanese otter researchers to boost conservation activities on otters. Among several otter-related problems, illegal trade of the Asian small-clawed otter (*Aonyx cinereus*) is one of the most serious one in Japan. To protect this species, its CITES Appendices rank was changed from II to I in August, 2019. Therefore, a new mandatory registration system for captive Asian small-clawed otters was started on November 26th in Japan under the LCES that protects all species listed on Appendix I of CITES. Hence, the AOCSJ has decided to hold a symposium on November 3rd to educate and discuss with the public about this new regulation system.

CONTENTS OF THE SYMPOSIUM

In this symposium, four presentations relating to the law and situation of captive Asian small-clawed otters in Japan were given by speakers and several topics were discussed during panel discussion time. The first talk, *"New regulations by the LCES on Asian small-clawed otters in Japan"* was presented by Hiroki Sato, Ministry of Environment. After a quick introduction on what CITES is, he explained what kind of regulations are going to be applied to living Asian small-clawed otters and Smooth-coated otters after the quick introduction of CITES. Important points are that more activities including renting, borrowing, giving and receiving otters will be regulated under the LCES in addition to buying and selling, which was not previously regulated at all. People will therefore need to register their otter before putting it into a pet hotel, as well as when advertising or exhibiting otters to sell. However, it should be remembered that no registration is necessary if people just keep otters privately without any commercial activity before these regulations came into force. Mr. Sato also explained what is needed to register an otter; the otter must have a microchip, and should be re-registered every five years. Registration date and expired date will therefore be needed when selling Asian small-clawed otters based on LCES. Lastly, punishment for illegal trading has been introduced.

Secondly, *"Otter trade and management system in Japan"* was presented by Tomomi Kitade from TRAFFIC, Head of Japan Office. In this presentation, Tomomi Kitade shared the current otter trade situation and management system in Japan. First, she showed that 47 otters were confiscated in smuggling incidents during 2016–2018, and six Japanese people were arrested. The urgent report published by TRAFFIC on October 2018 says over 90% of the otters commercially traded are Asian small-clawed otters, of which 25 were imported during 2016–2017 from Asian countries. Also, 19 individuals were imported for zoos or aquariums during 2000 and 2017. It was revealed that people normally sell otters online for USD 7,200-14,580. The number of otter cafes is increasing, and there have been some incidents where a couple of zoos have sold otters to animal dealers. The huge popularity of otters in Japanese society has occurred mainly because of the social media. Lastly, she pointed out several problems in this new legal regulation on captive otters. For example, stricter rules, such as DNA parentage testing, are needed to avoid smuggled otters being registered as legally imported or domestically bred in Japan. In conclusion, stricter rules and more publicity about them is needed, and the rules should be clarified so that it becomes very difficult to keep illegally acquired animals.

In the third talk, Sachiko Azuma from PEACE which is the animal advocacy NGO in Japan gave a presentation on "*Efforts for improvement on Act on Welfare and Management of Animals, and exhibited animals"*. Sachiko Azuma explained about efforts being made to improve the "Act on Welfare and Management of Animals", and to improve husbandry standards for captive animals. First of all, video of some captive Asian small-clawed otters kept in a poor environment was shown. Local governments can urge the owners to improve the animals' environment, based on this law, which was changed June, 2019 for the 4th times, and which will come into force; however, there is still no mandatory requirement to do so. Also, the "Act on Welfare and Management of Animals" relates to LCES: if a dealer is arrested based on LCES, then this person is not allowed to trade for five years, according to the new rules of the "Act on Welfare and Management of Animals". In addition to that, stricter rules will be applied to "First-class animal handling businesses" (animal dealers) after this change. However, it is not clear at present how this rule will work for captive animals other than dogs and cats. An additional resolution was also suggested when this law was changed, saying that establishment of captivity husbandry standards should be considered and some measures be taken to restrict the keeping of wild animals in captivity. Lastly, Ms. Azuma said that illegal trade has taken place leading to very poor animal welfare in Japan; we need far stricter rules to close down cafes or petting places that increase demand for private ownership of wild animals.

The last talk was, *"Management system and situation of captive Asian small-clawed otters in JAZA"*, given by Sakura Ito, Yokohama Zoological Gardens ZOORASIA. Sakura Ito explained about the management system and situation of captive Asian small-clawed otters at members of the Japanese Association of Zoos and Aquariums (JAZA). Firstly, the Asian small-clawed otter is designated as a "managed species", which means that pedigree registration and managed breeding are governed for this species by the person in charge of making domestic guidelines, husbandry instructions or research plans at the zoo or aquarium. Then, Ms. Ito indicated the approximate number of captive Asian small-clawed otters currently kept in JAZA institutions, and explained the process needed to transfer species designated as CITES I between holding institutions. Most of these individuals were born in Japan in captivity. In the future, JAZA has these goals; 1) to create a stable population of this species with good genetic diversity: 2) to carry out researches on reproductive physiology; and 3) to build a cooperative support and advice system with zoos, aquariums and rescue centers in South East Asia.

At the end of the symposium, a panel discussion was conducted by all speakers to explain further and reply to questions from the audience. Sample questions: 1) Permission from the prime minister is necessary for the transfer of an Asian small-clawed otter kept in zoos or aquariums? Answer was yes, people need the government permission in advance when transferring CITESI species. 2) Regarding to the additional resolution for improvement of animal welfare introduced in the third presentation, will it really come into force in the future? Answer was no, there is no guarantee this suggestion will be came into force because it has no legal power. 3) What kind of materials can be used for the DNA parentage test? Mr. Waku, one of the directors of our society, replied and said blood samples or hair roots can be used for this test.

CONCLUSION

The main theme of the symposium was very specialized, but we were able to discuss the law changes in the broad view because of variety of topics in each presentation. We hope this symposium will have a positive effect on the situation of captive Asian small-clawed otters in Japan.

In total, 55 people including several media journalists attended this symposium, and many questions were asked by the audience (Fig. 1). To solve the captive Asian small-clawed otter problem in Japan, public awareness and behavioral change is very important. The AOCSJ will continue its efforts for the conservation of otters, in and ex situ.

Figure 1. The scene

RESUME

CONSÉQUENCES DU NOUVEAU SYSTÈME D'ENREGISTREMENT OBLIGATOIRE POUR LES LOUTRES CENDRÉES (*Aonyx cinereus*) EN CAPTIVITÉ AU JAPON

L'Asian Otter Conservation Society of Japan (AOCSJ) a été créé, le 1er octobre 2019, par des chercheurs japonais pour stimuler les activités de conservation liées aux loutres. Le commerce illégal de loutres cendrées en captivité est l'un des problèmes les plus graves pour le bien-être animal au Japon. Cette situation est due à l'entrée en vigueur du nouveau système de règlementation de l'espèce, le 26 novembre, suite au changement en août 2019 du classement des annexes I et II de la CITES. Un symposium a été organisé par l'AOCSJ le 3 novembre 2019 afin de sensibiliser le grand public et de pouvoir en débattre. Lors de ce symposium, quatre présentations et une table ronde ont été organisés avec 55 participants, dont plusieurs journalistes de différents médias. Les points importants de ces présentations étaient :

1) plusieurs comportements de propriétaires, en ce compris le prêt, l'emprunt, le don et la réception de loutres seront réglementés en vertu de la Loi sur la Conservation des Espèces de la faune et de la flore sauvages Menacées d'Extinction (LCEME), pas uniquement l'achat et la vente ;

2) le numéro d'enregistrement, la date d'enregistrement et la date d'expiration seront nécessaires lors de la vente de loutres cendrées sur la base de la LCEME ;

3) des règles et une publicité plus strictes devraient être appliquées à cet enregistrement, et des règles claires sont nécessaires pour garantir que seules les loutres détenues légalement puissent être enregistrées à l'avenir. L'AOCSJ continuera de travailler pour sensibiliser et faciliter les changements de comportement du public à l'égard des loutres et soutenir une conservation plus efficace des populations sauvages en réduisant, voire en éliminant, nous espérons, la pression du commerce des animaux de compagnie sur les loutres cendrées au Japon.

RESUMEN

IMPLICANCIAS DEL NUEVO SISTEMA DE REGISTRO OBLIGATORIO PARA CAUTIVERIO DE NUTRIA DE UÑAS PEQUEÑAS ASIÁTICA (*Aonyx cinereus*) EN JAPÓN

La Sociedad para la Conservación de Nutrias Asiáticas de Japón (AOCSJ) fue establecida por investigadores japoneses en nutrias, el 1° de Octubre de 2019, para reforzar las actividades de conservación relacionadas con nutrias. El comercio ilegal de nutrias de uñas pequeñas asiáticas en cautiverio es uno de los más serios problemas de bienestar animal en Japón, y el 26 de Noviembre se estableció un nuevo sistema regulatorio para esta especie, como resultado del cambio en el Apéndice CITES en el que ésta se ubica -del II al I, en Agosto de 2019. Para educar al público acerca de ésto, y para discutirlo con el mismo, se realizó un simposio de AOCSJ el 3 de Noviembre de 2019. En el simposio, se compartieron cuatro presentaciones y una discusión con panelistas, con una audiencia de 55 personas, incluyendo varios periodistas. Los puntos importantes de estas presentaciones fueron: 1) varios comportamientos de los dueños, incluyendo alquiler, préstamo, donación y recepción de nutrias, van a ser regulados bajo la Ley para la Conservación de Especies Amenazadas de Fauna y Flora Silvestres (LCES), y no solamente la compra y venta; 2) para vender Nutrias de uñas pequeñas asiáticas, se va a necesitar el número de registro, fecha de registro y fecha de vencimiento, en base a la LCES; 3) deberían aplicarse reglas más estrictas y publicidad a la registración, y son necesarias reglas claras para asegurarse que en el futuro solamente se puedan registrar nutrias con tenencia legal. AOCSJ continuará trabajando para aumentar la conciencia y facilitar cambios de comportamiento del público, en lo que respecta a las nutrias, para apoyar una conservación más efectiva de las poblaciones silvestres reduciendo, y esperamos que eliminando, la presión sobre las nutrias de uñas pequeñas asiáticas generada por el comercio de mascotas Japonés.

OSG NEWS

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

Susanne Backe, Sweden: I am a biologist for the County Administrative Board of Norrbotten in northern Sweden. I´m responsible for the terrestrial monitoring programs of wetlands, birds and otters. We are working on comparing spraint survey results with environmental DNA, as well as toxin level determinations. I would like to work with people in other countries, and other otter species, to braoden this work.
Chabi Djagoun,Benin: I have worked in conservation with many different species since 2014. I have been working with otters in portions of West Africa (primarily Benin) and ams dedicated to continuing that work. I am currently Senior Lecturer at the Faculty of Agronomic Sciences, Natural Management Resource School. My interests include human needs and sustainable wildlife conservation. I am also interested in using otters as a focal point for educating children in local communities about aquatic education and other conservation issues..
Andrew Harrington, United Kingdom: I have worked with Otters for 20 years most recently trying to develop an acoustic deterrent to help stop conflict with fisheries with the University of Oxford.
Philip John, Singapore: I study the evolution of animal behaviour and social behaviours in otters. My students and I study social and group dynamics, including vocal communication, group foraging, group territorial defence, and interactions between romps and external disturbances (e.g., predators) of smooth-coated otters, and other species in SE Asia.
Swanand Patil, India: I am Swanand Rajan Patil aconservational biologist by profession I am alsoFounder and Director of an NGO called as "Arcane Conservancy", whose prime area of focus is to conductlong-term otter research and conservation along Ratnagiri on the west coast of Maharashtra. I have interned with Wild Otters, Goa and Lutra Innovation, under Atul Borker. Arcane Conservancy aims to develop Species-specific Management Strategies which are disseminated to Forest Department. I am interested in working on understanding otter-human interaction, otter adaptations, and diet in a coastal and a riverine landscape, along with generating outreach and education awareness among the local community
Lana Resende, Brazil: My interest is in the response of neotropical mustelids, especially otters, to anthropogenic environmental changes, and the occasional conflict. I am currently working on my Ph.D., investigating wide aspects of ecology and mustelids conservation across different environmental contexts in Atlantic Forest, wth Neotropical otters as the flagship species.
Colin Seddon, UK: I have worked in wildlife rehabilitation for 30 years. My main interest is the rehabilitation of otters back to the wild, and have handled over a hundred otter casualties, developing methods of rearing,housing,enclosure design,enrichment methods etc and in particular release methods including soft release,semi soft release and hard release. I am now retired, but providing advice on various wildlife rehabilitation matters including otter rehabilitation. I am also working with UKWOT, and hope to become more physically involved once COVID-19 restrictions are lifted.
Rafael Sousa, Brazil: I work with *Lontra longicaudis* in Rio Grande do Norte, on ecology, behaviour and welfare.

Isha Tickoo, India: I am a research associate with Wild Otters in Goa. As well as field research covering the impact of habitat disturbance on otter presence, understanding den usage patterns, dog-otter conflict and behavioural adaptations to an estuarine environment, I am enthusiastic about outreach and education, using social media as well as the preparation and delivery of educational material.

Jennifer Van Brocklin, USA: I am a program officer for the OSG and a graduate student in the Department of Fisheries and Wildlife at Oregon State University. My master's thesis focuses on an analysis of microplastic ingestion by sea and river otters in the North Pacific.

NEW BOOKS

Jessica has written another wonderful book! A must read!