# 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!

This time the good news is that I received the official information that the IUCN OSG Bulletin will be referenced in Scopus. As a result of this I have added a short text on ethics in science that I consider to be self evident to comply with. In addition and in line with many other journals all incoming manuscripts will undergo a plagiarism check using dedicated software (urkund.com). This service is sponsored by the Centre de Recherche Public – Gabriel Lippmann for which I would like to express my sincere thanks to my employer.

Not so long ago the "otter world" got a new PhD. Congratulations to Anna who successfully defended her thesis entitled "Contaminants and health in the Swedish otter (Lutra lutra)".

We are still looking for pictures of otters for which you need to be the copyright holder. If this is the case feel free to send them either to me or to Lesley.

Meanwhile all members have been re-invited to join the OSG. Except a few mistakes that can always happen the process was smooth. We are now on the start of a new period and I hope that you all look forward with great enthusiasm to the next years and especially the next International Otter Colloquium that will take place in Rio de Janeiro in August 2014.

My last lines are as usually used to thank Lesley for all your support, hours and work spend for the IUCN OSG Bulletin in several different functions. Thanks Lesley!

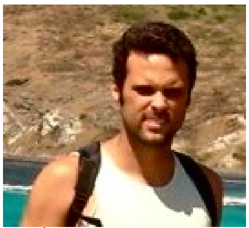
Arno

**A R T I C L E**

# A COMPARATIVE DIET ANALYSIS OF THE NEOTROPICAL OTTER IN SANTA CATARINA ISLAND, BRAZIL

Oldemar CARVALHO-JUNIOR[1], Luis MACEDO-SOARES[2],
Alesandra BEZ BIROLO[1], Tammy SNYDER[3]

*[1]Instituto Ekko Brasil, Servidão Euclides João Alves, S/N, Lagoa do Peri, 88066-000, Florianópolis, SC, Brazil. e-mail: atendimento@ekkobrasil.org.br*
*[2]Universidade Federal de Santa Catarina (UFSC), Post-graduation Program in Ecology, Campus Universitário Reitor João David Ferreira Lima, 88040-970, Trindade, Florianópolis, SC, Brasil*
*[3]Wildlife State of Nebraska, 2200 North 33rd Street, Lincoln, NE 68503, USA*

(Received 9th May 2013, accepted 17th August 2013)

**Abstract:** This work represents a comparative diet analysis of the neotropical otter *Lontra longicaudis* by scat analysis (n= 8841) for four different areas, located on Santa Catarina Island, south of Brazil. The study areas, the main ecosystems found on the Island, are all natural reserves. The results are based on long term data sets (2003-2009) comparing food item proportions through years, with inter-annual and monthly variability. For all study areas, fish (71%) and crustacean (25%) are the main food types, followed by mollusks (2%), birds (1%) and mammals (1%). In the case of main food categories, there is no observed inter-annual or monthly variability for the food items that compose the otter's diet. The results show that, on the Santa Catarina Island, the neotropical otter presents a well defined diet composition that does not change from place to place, and has no inter-annual or monthly variability.

*Keywords*: *Lontra longicaudis*, spraint analysis, habitats.

## INTRODUCTION

*Lontra longicaudis* is a semi-aquatic carnivorous mammal that belongs to the Mustelidae Family and Lutrinae Subfamily (Wilson and Reeder, 2005). The species is considered critically endangered by the Convention on International Trade in Endangered Species of Wild Fauna e Flora (CITES) and U.S. Endangered Species Act (U.S.E.S.A) (Emmons, 1997; Wilson and Reeder, 2005), and Data Deficient by the IUCN (Wilson and Reeder, 2005). In Brazil, the Fauna Protection Law that prohibits the commerce of products made from animals protects the otter. The species was recently considered endangered in the Atlantic Forest, according to the last meeting of Brazilian specialists at Iperó, São Paulo, organized by ICMBio (Chico Mendes Institute for the Biodiversity – Federal Environmental Agency).

In Brazil, the neotropical otter is threatened due to various reasons, such as destruction of aquatic and riparian habitat, reduction of the otters' fishing and relaxation areas, hunting promoted by farmers, fishermen and aquaculture, and the presence of domestic animals such as dogs (Serfass et al., 1995; Stickney and McVey

2002; Adámek et al., 2003; Kloskowski 2005; Boyle 2006; Park et al., 2007). Neotropical otters are not popular with fishermen and aquacultures, for example, who claim that otters are prejudicial; damaging nets, eating cultivated fishes, and impacting mussel and oyster farms (Alarcon and Simões-Lopes, 2004; Trindade, 1991).

Neotropical otter conservation along the coastal region of Santa Catarina state is dependent upon on the conservation of the Atlantic Rain Forest, currently endangered by human activities. Stratification of the forest, along with the high density of epiphytes represents an important contribution to the formation of safe environments for the *Lontra longicaudis* (Carvalho-Junior et al., 2006). The main threat for the otter is fragmentation of the environment. Fragmentation results in a mosaic of patches with increasing threat to otter conservation as the distance between patches increases. Neotropical otters are constantly moving from place to place and they need trustable ecological corridors to complete a safe journey (Carvalho-Junior, 2007). A second threat is the presence of domestic dogs in the study area. Domestic dogs walk freely along the lake and channels, representing a serious threat as they can transmit diseases as well as chasing and killing wild animals, including otters (Serfass et al., 1995; Boyle, 2006; Park et al., 2007).

Distribution of the neotropical otter is based on scarce and sparse data which results in lack of information about the neotropical otter's natural life. According to Emmons (1997) the neotropical otter can be found in Central and South America, from Mexico south to Uruguay and up to 3.000 m elevation. In South America the species is registered for Argentina, Belize, Brazil, Columbia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela (Wilson and Reeder, 2005).

In Santa Catarina State, *Lontra longicaudis* can be found from the highlands (to 1.200 m) to the coast, forests, rivers, lakes and costal islands (Quadros and Monteiro-Filho, 2001; Alarcon and Simões-Lopes, 2004; Carvalho-Junior et al., 2010a,b).

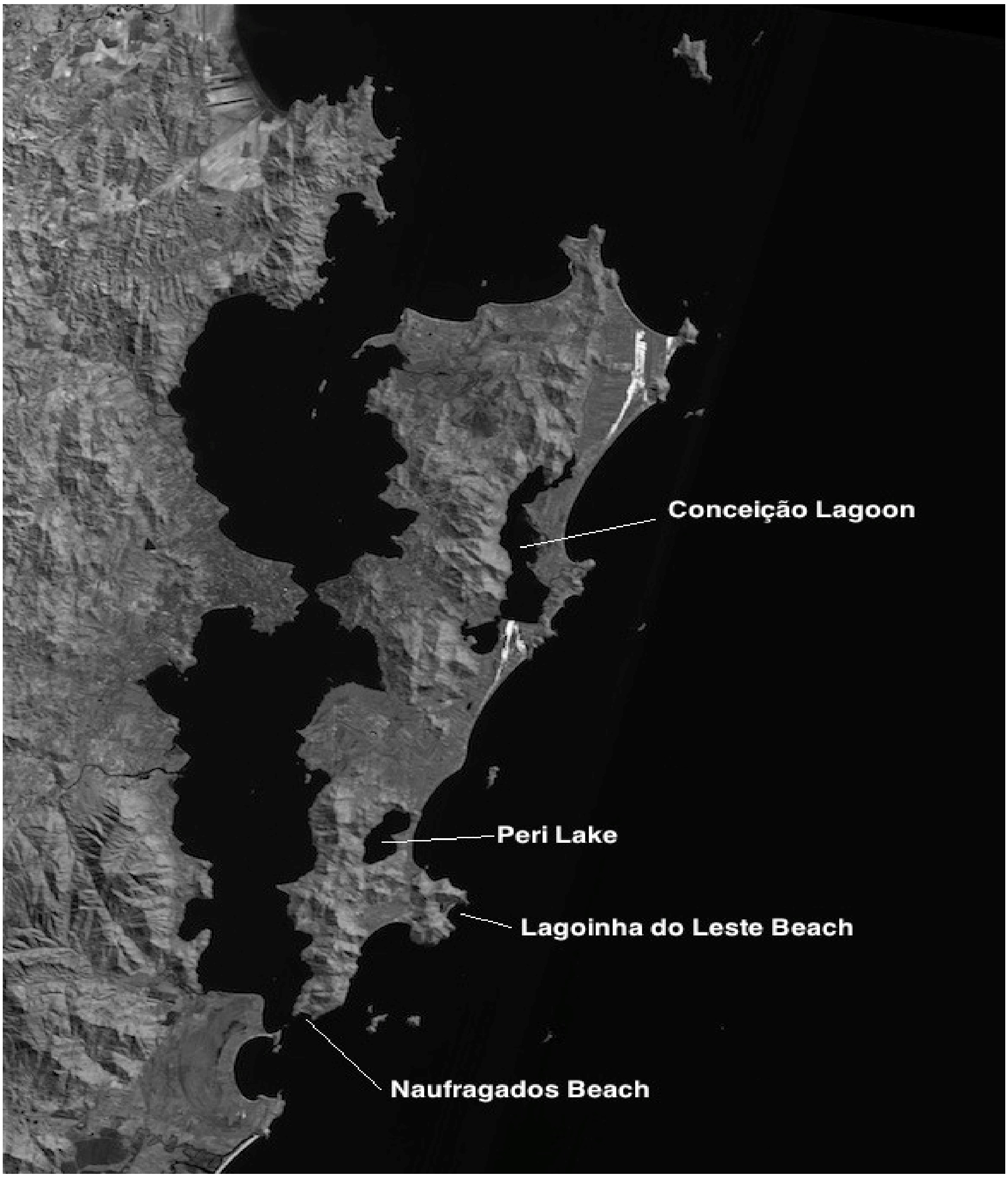
A great majority of the works related to *Lontra longicaudis* confirm that the otter's diet in Brazil is formed mainly by fish and crustaceans (Uchôa et al., 2004; Quadros and Monteiro-Filho, 2001; Quintela et al., 2008; Rheingantz et al., 2011). Uchôa et al. (2004), in the Reserva Natural Salto Morato (São Paulo) found that 72% of the neotropical otter's diet consists of fish, crab and shrimp. Quadros and Monteiro Filho (2000), found that, for the Volta Velha Reserve (SC), the most consumed prey are fish (74.26%) and crustaceans (62.87%). Also Pardini (1998), at the Betari River, a Touristic State Park - Ribeira Valley (SP), found that fish (93%), crustaceans (72.4%) and insects (21%) were the main items in the otter's diet. Quintela et al. (2008) studying a coastal stream in Rio Grande do Sul State, Brazil, define the diet of the species as fish (82,6%), followed by crustaceans (20,6%), birds (4,5%), mammals and snakes (3,7% each), coleoptera (1,2%), amphibians (0.8%) and gastropod mollusks and belostomatídeos (0.4% each).

Studies related to diet composition of otters in the Santa Catarina Island (Florianópolis) were performed previously (Carvalho-Junior et al, 2010a). A previous study conducted at Conceição Lagoon reveals that fish and crustacean are the main food items, followed by mollusks, birds and mammals, showing no inter-annual or monthly variability. Another study performed at Peri Lagoon found similar results (Carvalho-Junior et al., 2010b).

However, a comparative work at the same time, for different areas, had not been previously attempted. The purpose of this work is to compare the neotropical otter's diet composition in four different study areas of Santa Catarina Island, in the south of

Brazil, describing possible differences through annual and inter-annual diet composition.

The diet is perhaps the most studied aspect of the neotropical otter, due to the facility of data collection and analysis of excrements. Nevertheless, authors seem to disagree on the facts as to whether the species is opportunist or specialist. For example, for Chanin (1985), otters are considered opportunistic predators due to their plasticity when feeding in different environments. Moreover, Kruuk (1995), using Kendall's Coefficient of Concordance, states that the river otter is one of the most specialized animals. The results presented here could be important to help to clarify this matter.




## STUDY AREA

**Figure 1.** Study areas located in Santa Catarina Island, South of Brazil: Conceição Lagoon, Peri Lake, Lagoinha do Leste Beach and Naufragados Beach.

Santa Catarina Island (Figure 1) represents the largest island of the Santa Catarina State, located parallel to the mainland and separated by a narrow channel (Carvalho-Junior et al., 2012). It has an average length of 54 km and width average of 18 km. Bays, promontories, smaller islands and lagoons are common features in the study area. The most important water bodies in the Santa Catarina Island are the Peri Lake (5,1 $km^2$) and Conceição Lagoon (19,71 $km^2$). A study related to the distribution and characteristics of environments used by the neotropical otter in the coastal region of Santa Catarina state (Carvalho-Junior et al., 2004a) and in the south of Santa Catarina Island (Carvalho-Junior et al., 2004b), pointed out the importance of the indented coastline for the *Lontra longicaudis*.

## METHODS

Between 2003 and 2009, spraints were collected monthly in four areas of Santa Catarina Island: Lagoa do Peri, Naufragados Beach, Lagoa da Conceição and Lagoinha do Leste Beach (Figure 1). The study areas were covered using canoes and kayaks. Fecal samples were collected and placed individually in small plastic bags and stored in a refrigerator. In the lab, each sample was washed through a mesh and the undigested remains analyzed under a stereomicroscope. Diet composition was determined from a total of 8.841 fecal samples and expressed as percentage relative frequency of occurrence (RF%).

The chi-squared was used (Zar, 1996) to test the variation of food items among years and areas. When any significant differences were found, Tukey HSD for unequal sample sizes was performed to detect which means were responsible for the difference with a 0.05 level of probability. Raw proportion diet composition data were arcsine square root transformed when the Tukey test was performed (Zar, 1996). Tukey test is applied when the null hypothesis is rejected.

Due to the size of the database, the data tend to a normal distribution. Therefore, the ANOVA is applied because it is much more robust than a nonparametric test, even when the data do not present a classic and perfect normal distribution. In this case, a test like ANOVA can indeed provide a reliable result, given the sample size.

Unifactorial Analysis of Variance (1-way ANOVA) was applied to test for variation in the number of faeces found in different years and months, for each study area and for Santa Catarina Island. Bartlett's test was used to verify the homogeneity of variances, while *post-hoc* Tukey's tests were used to explain differences found by ANOVA. All data were [$\log_{10}(x+1)$] transformed in order to stabilize the variance and fit the data to a normal distribution (Zar, 1996). The relationship between the number of faeces and the number of the food item fish found in the samples was tested with the Pearson correlation index (Zar, 1996). All tests were performed by Statistica 7.0 (Statsoft Inc. 1984-2004).

## RESULTS AND DISCUSSION

From the results we can recognize different prey categories, such as fish, crustacean, mollusk, bird and mammal. In the study period, fish (71%) and crustaceans (25%) were the main food items of otters in all study areas and years (Figures 2 and 3), followed by mollusks (2%), birds (1%) and mammals (1%). The results show that neotropical otters in the study area feed mainly on fishes, followed by crustaceans.

There is no observed inter-annual or monthly variability for the food items that compose the otter's diet. On the whole, in Santa Catarina Island, no difference emerged in the %RF of the main food items among years (Tab. 1), while significant differences were found for fish and crustaceans among study areas (Tab. 1). However, the preference for the main food items was always the same, being fish (first) and crustacean (second). Proportionally, the smallest occurrence of fish in the diet was found for Lagoa da Conceição, where otter predation on crustaceans was also the highest.

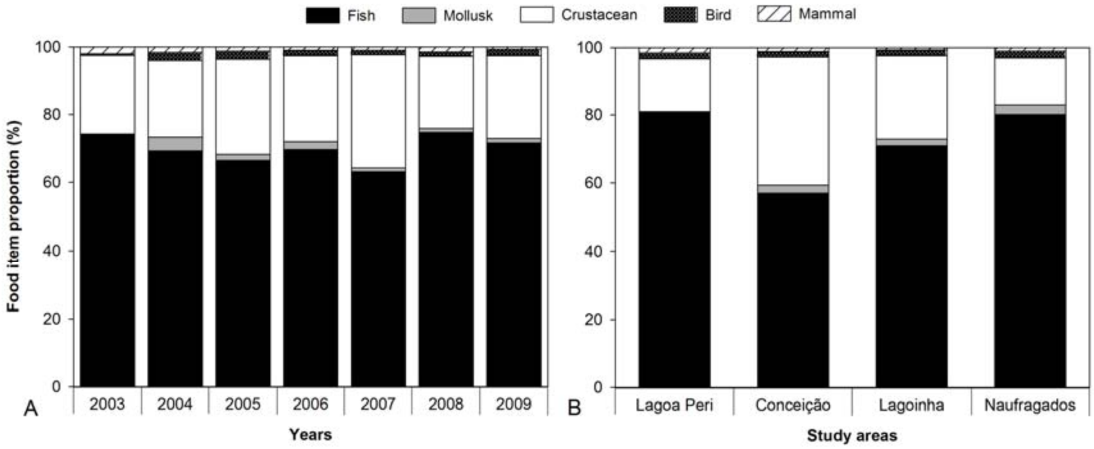



**Figure 2.** Comparison of diet through years (A) and between study areas for all years (B).

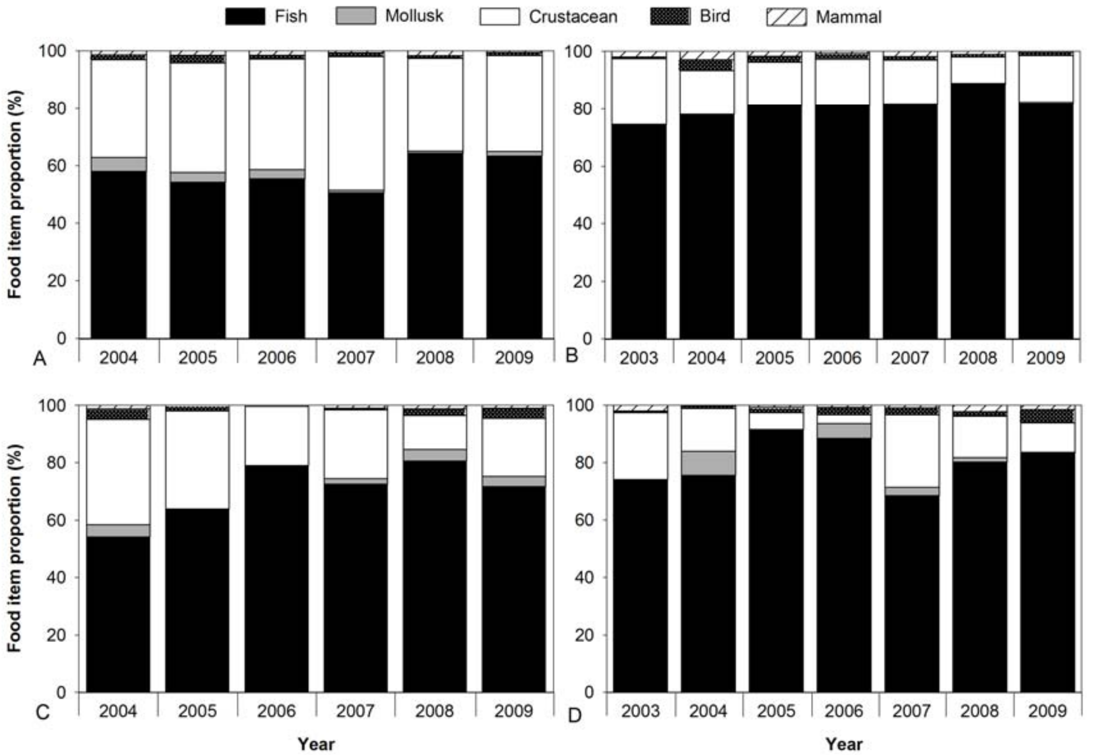



**Figure 3.** Food item proportion for: (A) Lagoa da Conceição, (B) Lagoa do Peri, (C) Lagoinha do Leste and (D) Naufragados.

This might be reflective of the fact that Lagoa da Conceição has the influence of the sea. Consequently, compared to Lagoa do Peri, there is a higher biodiversity in the area and wider availability of prey (Carvalho-Junior et al., 2010a). Lagoa do Peri is a fresh water lake, with a narrower range of potential prey (Carvalho-Junior et al., 2010b). Therefore, important aspects to be considered are food availability and water quality (Kruuk et al., 1991; Kruuk, 1995; Chanin, 2003). Fish species predated by the neotropical otter might change according to abundance, habitat and seasonality (Kruuk, 2006), as well as ecosystem productivity.

When testing for variation among years for each study area, the proportion of fish at Lagoinha do Leste was significantly higher (*P*<0,05) in 2008, while that of crustacean was higher in 2004, when fish occurrence was the lowest (Tab. 1). In Naufragados Beach, significant variation occurred for fish, mollusks and crustacean.

Perhaps, in the case of lack of fish, the otter could change the proportion of crustaceans in the diet. In fact, studies at Lagoa da Conceição show that the crustacean is relatively more important when compared to other areas as Lagoa do Peri (Carvalho-Junior et al., 2006). As the diet composition is obtained from faeces, number of faeces can also be important to the analysis (Figure 4).

**Table 1.** Food items proportions that compose the otter's diet. Qui-square is applied to test the hypothesis that the food item proportion does not vary between years and between study areas. Letters indicate different means from Tukey Test (ns = no significant; * *P*<0.05; SC = Santa Catarina).

**Qui-square results**

| | Fish | Mollusk | Crustacean | Bird | Mammal |
|---|---|---|---|---|---|
| Conceição Lagoon | $5.850^{ns}$ | $5.236^{ns}$ | $5.91^{ns}$ | $1.156^{ns}$ | $0.938^{ns}$ |
| Peri Lake | $6.896^{ns}$ | $1.650^{ns}$ | $3.299^{ns}$ | $3.505^{ns}$ | $2.889^{ns}$ |
| Lagoinha da Leste Beach | 23,426* | $8.459^{ns}$ | 23.291* | $4.727^{ns}$ | $2.208^{ns}$ |
| Naufragados Beach | 25.179* | 20.597* | 27.153* | $3.648^{ns}$ | $2.157^{ns}$ |
| SC Island across years | $5.031^{ns}$ | $3.944^{ns}$ | $5.098^{ns}$ | $0.704^{ns}$ | $0.557^{ns}$ |
| SC Island across areas | 18.504* | $2.299^{ns}$ | 20.236* | $0.030^{ns}$ | $0.364^{ns}$ |

**Tukey test results**

| | Fish | Mollusk | Crustacean |
|---|---|---|---|
| Lagoinha da Leste Beach | $08^{a}$ $06^{ab}$ $07^{ab}$ $09^{ab}$ $05^{bc}$ $04^{c}$ | ns | $04^{a}$ $05^{a}$ $09^{a}$ $06^{a}$ $07^{ab}$ $08^{b}$ |
| Naufragados Beach | $05^{bc}$ $06^{ab}$ $09^{ab}$ $08^{abc}$ $03^{bc}$ $04^{bc}$ $07^{c}$ | $04^{a}$ $06^{b}$ $07^{b}$ $08^{b}$ $09^{b}$ $03^{b}$ $05^{b}$ | $07^{a}$ $03^{ab}$ $04^{abc}$ $08^{abcd}$ $09^{bcd}$ $05^{cd}$ $06^{d}$ |
| SC Island across areas | Peri Lake$^{a}$; Naufragados Beach$^{c}$; Lagoinha do Leste Beach$^{a}$; Conceição Lagoon$^{b}$ | ns | Conceição Lagoon$^{a}$; Lagoinha do Leste Beach$^{ab}$; Peri Lake$^{bc}$; Naufragados Beach$^{c}$ |

According to the ANOVA, the number of faeces are different between years for Lagoa da Conceição (F=14.229; *P*<0.001), Lagoinha do Leste Beach (F=6.845; *P*<0.001) and Naufragados Beach (F=2.319; *P*=0.0413) (Figure 4). At Lagoa do Peri, the number of faeces did not show any difference between years (F=0.664; *P*=0.6789) (Fig. 4B). At Lagoa da Conceição a smaller amount of faeces is found in 2004 (Figure 4A) while in Lagoinha do Leste, 2009 presented the lowest amount (Figure 4C). For Naufragados Beach, 2005 was the peak (*P*<0.05) of number of faeces with 2007 registering the minimum (Figure 4D). Differences between years for number of faeces might be suggesting that the number of otters varies with time at Lagoa da Conceição, Lagoinha do Leste and Naufragados Beach.

Lagoa da Conceição represents the largest water body ecosystem in the island. Its contact to the ocean is reflected in the seasonal and interannual variation of fish and crustacean stock (Ribeiro et al., 1997a; Ribeiro et al., 1997b). This could affect the distribution of otters through months and years. On the other hand, Lagoinha do Leste and Naufragados beach are the smallest water bodies. Their water levels are highly influenced by precipitation, opening or closing the access channels to the ocean. Therefore, biomass of preys can be highly affected by this dynamic, influencing also on the neotropical otter presence. These last two areas might be more important as a support to the otter's movement from one region to another.

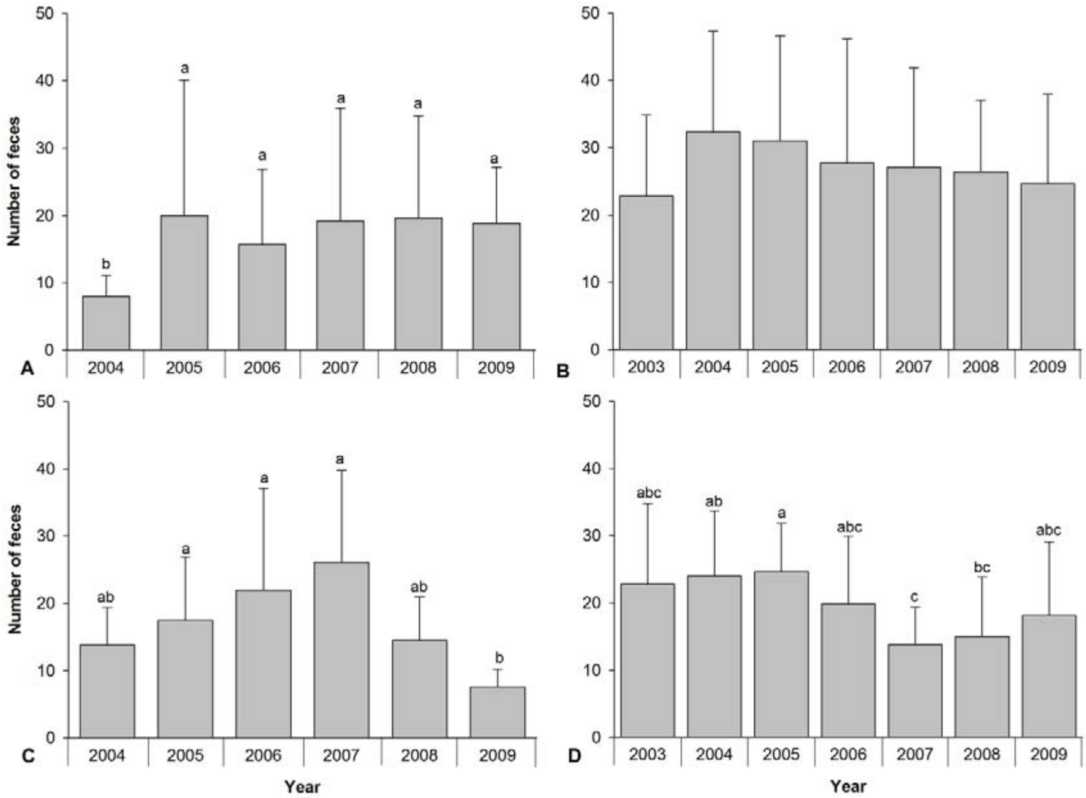



**Figure 4.** Distribution of number of faeces (mean±sd) through years (2003 to 2009) in the different study areas: (A) Lagoa da Conceição, (B) Lagoa do Peri, (C) Lagoinha do Leste Beach and (D) Naufragados Beach. Letters indicate different means according to Tukey test (A and D) and Duncan test (C).

On the other hand, Lagoa do Peri is a fresh water lagoon, connected to the ocean through a channel but not influenced by sea water. The lagoon is 3 meters above sea level and the channel is 4,5 km long, running parallel to the coastline. The fish population at this ecosystem is more stable and homogenous, composed mainly by Cichlidaes, when compared to Lagoa da Conceição. In fact, 90% of the fish consumed by neotropical otters in the area are Cichlidaes (Carvalho-Junior et al, 2010a). The only crustacean in the lagoon is the fresh-water-lobster (*Macrobrachium sp.*).

For Santa Catarina Island, 1-way ANOVA resulted in differences between years for number of faeces ($F=2.172$; $p=0.0457$) and between areas ($F=13.942$; $P<0.001$).

2005 is the year with the highest number of faeces collected ($P$<0.05) (Figure 5A), as well as for Lagoa de Peri (Figure 5B).

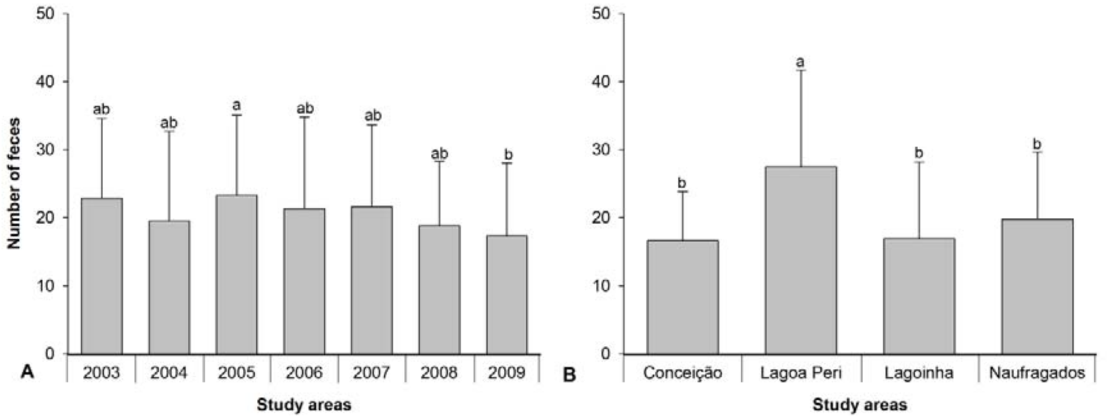



**Figure 5.** Distribution of number of faeces (mean±sd) through (A) years 2003 (only for Lagoa do Peri and Naufragados beach) to 2009, and (B) in the different study areas.

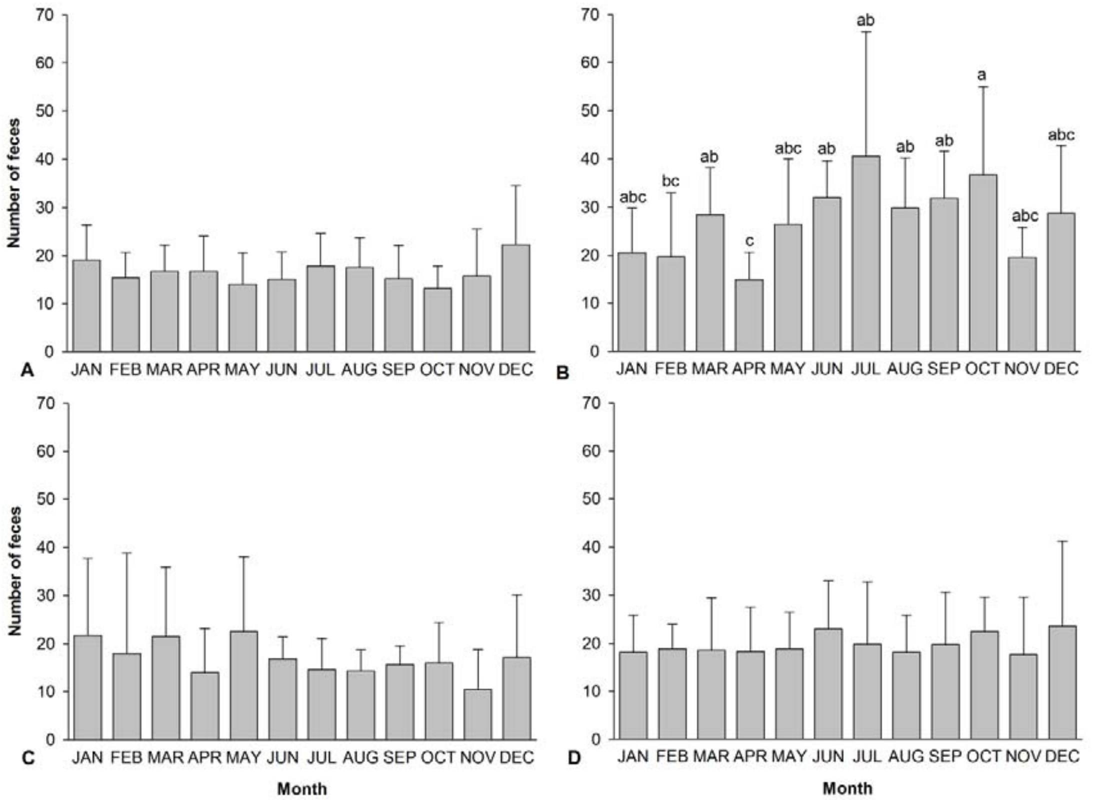



**Figure 6.** Number of faeces (mean±sd) distribution through months in the different study areas: (A) Lagoa da Conceição, (B) Lagoa do Peri, (C) Lagoinha do Leste beach and (D) Naufragados beach. Letters (a, b, c) indicate different means according to Duncan test.

When monthly distribution of number of faeces was analyzed in each study area, no significant ($P$>0.05) differences were found for Lagoa da Conceição (F=0.551; $P$=0.859), Lagoinha do Leste Beach (F=0.504; $P$=0.893) and Naufragados Beach (F=0.262; $P$=0.991) (Figure 6). In Lagoa do Peri number of faeces is larger (F=2.018; $P$=0.039) in October and smaller in April (Figure 6B). On the other hand, when grouping the data and considering Santa Catarina Island, number of faeces does not change between months (F=1.232; $P$=0.265).

Lagoa do Peri is a fresh water lake, near the ocean, well protected, surrounded by Atlantic Forest and with 8 shelters available (Carvalho-Junior, 2007). The larger number of faeces could be an indication of habitat preference by the *Lontra longicaudis*. This area might represent a hot spot, important for the survival of the neotropical otter population in the Santa Catarina Island. On the other hand, the stable number of spraints along the year through the study areas suggests that the population is well distributed or mixed.

Establishing a relation between number of spraints and otters population size is a difficult task (Kruuk, 2006). Spraints can be washed by rain or tide, otters might defecate on land more times than in the water during winter, or defecate in areas of difficult access. However, if there are spraints it means there are otters. On the other hand, the absence of spraints does not really mean that there are no otters in the area. In the present case the survey was performed for a long period of time (8 years). As a consequence, the discrepancy between averages tends to be lower.

The results give a good idea of the neotropical otter's diet on the Santa Catarina Island and can contribute to the discussion of the neotropical otter being specialist or opportunist. It also raises questions about the connection between ecosystems and how the neotropical otter population is geographically organized. The conservation of the species depends on the knowledge we have about it. Diet composition can help us to find out how sensitive and what is the adaptive capacity of the neotropical otter to environmental changes due to habitat loss, over exploitation, invasive species and climate change.

**Acknowledgements** - This work is sponsored by Petrobras, trough Petrobras Environmental Program (Programa Petrobras Ambiental) and supported by FLORAM (Fundação Municipal do Meio Ambiente de Florianópolis) and IBAMA (Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis). We would like to acknowledge Marcelo Tosatti for helping with the fieldwork. We also thank the staff of the State Protection Environmental Police "Dr. Fritz Muller" at the Rio Vermelho State Park for their assistance and all ecovolunteers that participated in the field, and to Sandra Quiñones Herce for translating the abstract to Spanish.

## REFERENCES

**Adámek Z., Kortan D., Lepic P., Andreji J. (2003)**. Impacts of otter (*Lutra lutra* L.) predation on fishponds: A study of fish remains at ponds in the Czech Republic. *Aquaculture International*. **11(4)**: 389-396.

**Alarcon, G.G., Simões-Lopes, P.C. (2004)**. The Neotropical otter *Lontra longicaudis* feeding habits in a marine coastal area, Southern Brazil. *IUCN Otter Spec. Group Bull.,* **21(1)**: 24-30.

**Boyle, S. (2006)**. North American river otter (*Lontra canadensis*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. [Available from http://www.fs.fed.us/r2/projects/scp/ assessments/northamericanriverotter.pdf Accessed 20.08.2010].

**Carvalho-Junior, O., Banevicius, N.M.S., Mafra, E.O. (2006)**. Distribution and caracterization of environments used by otters. *Journal of Coastal Research*, **39**: 1087-1089.

**Carvalho-Junior, O.; Fillipini, A.; Salvador, C. (2012)**. Distribution of neotropical otter, *Lontra longicaudis* (Olfers, 1818) (Mustelidae) in coastal islands of Santa Catarina, Southern Brazil. *IUCN Otter Spec. Group Bull.,* **29(2)**: 95–108.

**Carvalho-Junior O., Birolo A.B., Macedo-Soares L.C.P. (2010*a*)**. Ecological aspects of Neotropical otter (*Lontra longicaudis*) in Peri Lagoon, South Brazil. *IUCN Otter Spec. Group Bull*., **27(2)**: 105-115.

**Carvalho-Junior O., Macedo-Soares L.C.P., Birolo A.B. (2010*b*)**. Annual and interannual food habits variability of a Neotropical otter (*Lontra longicaudis*) population in Conceição Lagoon, South of Brazil. *IUCN Otter Spec. Group Bull*., **27(1)**: 24–32.

**Carvalho-Junior, O. (2007)**. No Rastro da Lontra Brasileira. Ed. Bernuncia, Florianópolis, Brasil, 112pp.

**Carvalho-Junior, O. (2004*a*)**. Spatial organization of river otter *Lontra longicaudis* in the south of

Santa Catarina Island, Brazil. Proceedings of the 11 Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de America del Sur. Quito: NAZCA, p. 63.

**Carvalho-Junior, O., Banevicius, N.M.S., Mafra, E.O. (2004*b*)**. Distribution and characterization of environments used by otters in the coastal region of Santa Catarina State, Brazil. *Journal of Coastal Research*, **39**: 1087-1089.

**Chanin P. (1985)**. The Natural History of Otters, Elsevier, London.

**Chanin P. (2003)**. Ecology of the European Otter. Conserving Natura 2000 Rivers. Ecology Series 10.

**Emmons, L. (1997)**. Neotropical rainforest mammals: a field guide. 2nd ed. The University of Chicago Press, Chicago, 307p.

**Kloskowski J. (2005)**. Otter *Lutra lutra* damage at farmed fisheries in southeastern Poland, I: an interview survey. *Wildlife Biology*, **11(3)**: 201-206.

**Kruuk H., Conroy J.W.H., Moorhouse A. (1991)**. Recruitment to a population of otters (*Lutra lutra*) in Shetland, in Relation to Fish Abundance. *Journal of Applied Ecology*, **28(1)**: 95-101.

**Kruuk H. (1995)**. Wild Otters. Predation and Populations. Oxford University Press, New York.

**Kruuk H. (2006)**. Otters. Ecology, Behaviour and Conservation. Oxford University Press, New York.

**Pardini, R. (1998)**. Feeding ecology of the neotropical otter *Lontra longicaudis* in an Atlantic forest stream, south Brazil. *J. Zool. London*, **245**: 385-391.

**Park, N.Y., Lee, M.C., Kurkure, N.V., Cho, H.S. (2007)**. Canine adenovirus type 1 infection of a Eurasian river otter (*Lutra lutra*). *Vet. Pathol*, **44**:4.

**Quadros J., Monteiro-Filho E.L.A. (2000)**. Fruit occurrence in the diet of the Neotropical otter, *Lontra longicaudis*, in the Southern Brazilian Atlantic Forest and its implication for seed dispersion. I. *J. Neotrop. Mammal,* **7(1)**: 33-36.

**Quadros J., Monteiro-Filho E.L.A. (2001)**. Diet of the Neotropical otter, *Lontra longicaudis*, in the Atlantic Forest, Santa Catarina State, Southern Brazil. *Studies on Neotropical Fauna and Environment*, **36(1)**: 15-21.

**Quintela, F.M., Porciúncula, R.A., Colares, E.P. (2008)**. Diet of *Lontra longicaudis* (Olfers) in a coastal stream in southern Rio Grande do Sul State, Brazil. *Neotrop. Biol. Cons.*, **3(3)**: 119-125.

**Rheingantz, M.L., Waldemarin, H.F.; Rodrigues, L., Moulton, T. (2011)**. Seasonal and spatial differences in feeding habits of the Neotropical otter *Lontra longicaudis* (Carnivora: Mustelidae) in a coastal catchment of southeastern Brazil. *Zoologia*, **28 (1)**: 37–44.

**Ribeiro, G.C., Clezar, L., Hostim-Silva, M., Filomeno, M.J.B., Aguiar, J.B.S. (1997)**. Ictiofauna da Lagoa da Conceição e área costeira adjacente, Ilha de Santa Catarina, SC, Brasil. In: Gestion de La Zone Littorale L'ile de Santa Catarina (Bresil), Publication Du Departement de Geologie et Oceanographie URA CNRS 197, Universite de Bordeaux 1, **Aquitaine Ocean (3)**: 275-280.

**Ribeiro, G.C., Clezar, L., Hostim-Silva, M. (1997)**. Abundância e distribuição espaço-temporal dos Gerreidae (pisces) na Lagoa da Conceição e área adjacente, Ilha de Santa Catarina, SC, Brasil. In: Gestion de La Zone Littorale L'ile de Santa Catarina (Bresil), Publication Du Departement de Geologie et Oceanographie URA CNRS 197, Universite de Bordeaux 1, **Aquitaine Ocean (3)**: 281-286.

**Serfass, T.L., Whary, M.T., Peper, R. L., Brooks, R.P., Swimley, T.J., Lawrence, W.R., Rupprecht, C.E. (1995)**. Rabies in a river otter (*Lutra canadensis*) intended for reintroduction. *Journal of Zoo and Wildlife Medicine*, **26(2)**: 311-314.

**Stickney R.R., McVey J.P. (2002)**. Responsible Marine Aquaculture. World Aquaculture Society, CABI Publishing, USA.

**Trindade, A. (1991)**. Fish Farming and Otters in Portugal. *IUCN Otter Spec. Group Bull.,* 6: 7-9.

**Uchôa, T., Vidolin, G.P., Fernandes, T.M., Velastin, G.O., Mangini, P.R. (2004)**. Aspectos ecológicos e sanitários da lontra (*Lontra longicaudis* OLFERS, 1818) na Reserva Natural Salto Morato, Guaraqueçaba, Paraná, Brasil. *Cad. Biodivers.,* **4(2)**: 19-28.

**Wilson, D. E.; Reeder, D. M. (2005).** Mammal species of the world: a taxonomic and geographic reference. 3rd ed. The Johns Hopkins University Press, **V. 1**, 743p.

**Zar J. H. (1996)**. Biostatistical analysis. 3 ed. Prentice Hall, New Jersey.

## RÉSUMÉ

**ANALYSE COMPARATIVE DU REGIME ALIMENTAIRE DE LA** LOUTRE À LONGUE QUEUE **SUR L'ILE SANTA CATARINA, BRESIL**

Ce travail présente l'étude comparative du régime alimentaire de la Loutre à Longue Queue *Lontra longicaudis* grâce à l'analyse de ses excréments (n = 8841) dans quatre zones géographiques différentes sur l'île de Santa Catarina, au sud du Brésil. Les zones d'étude, reflets des écosystèmes présents sur l'île, sont toutes des réserves naturelles. Les résultats sont basés sur des prélèvements collectés sur le long terme (2003-2009), comparant les proportions de chaque reste sur plusieurs années et précisant la variabilité inter-annuelle et mensuelle. Pour toutes les zones, les poissons (71%) et les crustacés (25%) sont les principales proies, suivis par les mollusques (2%), les oiseaux (1%) et les mammifères (1%). Pour les principales catégories de proies, il n'y a pas de variabilité inter-annuelle ou mensuelle observée. Les résultats montrent que, sur l'île de Santa Catarina, la Loutre géante présente une composition alimentaire bien définie qui ne change pas de place en place, et n'a pas de variabilité inter-annuelle ou mensuelle.

**RESUMEN**

**UNA COMPARATIVA DEL ANÁLISIS DE LA DIETA DE LA NUTRIA NEOTROPICAL EN LA ISLA DE SANTA CATARINA, BRASIL**

Este trabajo representa una comparativa del análisis de la dieta de la nutria neotropical Lontra longicaudis mediante el análisis de excrementos (n=8841) en cuatro áreas diferentes localizadas en la isla de Santa Catarina, en el sur de Brásil. Las áreas de estudio, los principales ecosistemas encontrados en la isla, son todos reservas naturales. Los resultados están basados en datos a largo plazo (2003-2009) comparando las proporciones de productos alimenticios a través de los años, con una variabilidad interanual y mensual. Para todas las áreas de estudio, pescado (71%) y crustáceos (25%) son los principales tipos de comida, seguido de moluscos (2%), pájaros (1%) y mamíferos. En el caso de las principales categorías de comida, no se ha observado variación interanual o mensual de los productos alimenticios que componen la dieta de la nutria. Los resultados muestran que en la isla de Santa Catarina, la nutria neotropical presenta una dieta bien definida que no cambia de un lugar a otro y que no tiene variabilidad interanual o mensual.

**RESUMO**

**ANÁLISE COMPARATIVA DA DIETA DA LONTRA NEOTROPICAL NA ILHA DE SANTA CATARINA, BRASIL**

Este trabalho representa uma análise comparativa da dieta de lontra neotropical (*Lontra longicaudis*) por análise de excremento (n= 8841) para quatro diferentes áreas, localizadas na Ilha de Santa Catarina, sul do Brasil. As áreas de estudo, os principais ecossistemas encontrados na Ilha, são todas reservas naturais. Os resultados são baseados em bancos de dados de longo termo (2003-2009) comparando proporções dos itens alimentares através dos anos, com variabilidade inter-anual e mensal. Para todas as áreas de estudo, peixes (71%) e crustáceos (25%) representam os principais itens alimentares, seguidos por moluscos (2%), aves (1%) e mamíferos (1%). No caso das principais categorias alimentares, não é observado variabilidade inter-anual ou mensal para os itens alimentares que compõem a dieta da lontra. Os resultados mostram que, na Ilha de Santa Catarina, a lontra neotropical apresenta uma dieta bem definida, que não muda de local para local, e não varia ao longo dos meses e entre os anos.

**R E P O R T**

# RE-COLONISATION OF THE EURASIAN OTTER (*Lutra lutra*) IN THE HRON RIVER CATCHMENT (SLOVAKIA) – A PRELIMINARY REPORT FROM A SURVEY, OR WHO REINTRODUCED THE OTTER IN THE HRON RIVER AND WHY?

Peter URBAN

*Department of Biology and Ecology, Faculty of Natural Sciences, University of Matej Bel, Tajovského 40, SK-974 01 Banská Bystrica, Slovakia.*
*e-mail:* Peter.Urban@umb.sk *or urbanlutra@gmail.com*

(Received 25th May 2013, accepted 31st July 2013)

**Abstract:** The Eurasian otter (*Lutra lutra*) is widely distributed in Slovakia. The population of this species markedly decreased during the 20th century. In the last two decades an increase and a colonizing tendency of the population species range have been registered. A similar trend took place in the Hron River catchment. The modified standard IUCN/OSG method for monitoring of the Eurasian Otter population was used in three field censuses of the otter distribution in the Hron River catchment. Results were obtained at two resolutions, an approximately 10×12 km grid from the "Databank of Slovak Fauna (DSF)", corresponding to 48 quadrates and higher resolution resulting from the subdivision of the first grid corresponding to 152 quadrants of approximately 2.5×3km). During the first survey (in winter of 1995/1996) 35 quadrates (72.9 %) and 73 quadrants (48.0 %) were positive. During the second survey (in summer and autumn of 2010) 45 quadrates (93.7 %), or 116 quadrantes (76.3%) were found positive. During the third mapping (in winter of 2011/2012) 45 quadrates and 120 (78.9%) quadrates were positive. Results of two recent regional surveys (2010, 2011/2012) documented an increase in percentage of positive sites for otter and an increase in the range occupied by otters in the Hron River catchment when compared to that in 1995/1996. The increase was most pronounced in the central part of the catchment and probably related with improvement of the surface water quality in 1980s and 1990s.

**Key words:** mapping, distribution, quadrates, Databank of Slovak Fauna, *Lutra lutra*

## INTRODUCTION

The Eurasian Otter, *Lutra lutra* (Linnaeus, 1758), is a native (original) fully protected and controversial mammal species in Slovakia. Historically, the otter was common throughout the country with the exception of the uppermost parts of high mountains (e.g. Hell and Cimbal, 1978). The otter population markedly decreased during the 19th and 20th centuries due to man-made changes, such as decrease of available sites (destruction, degradation and habitat fragmentation , habitat change and loss) - caused by river regulation and watershed changes, water pollution and illegal hunting and killing. In the second half of the 20th century, the decline of otters accelerated (Urban and Kadlečík, 2001; Urban et al., 2010a). The Slovak otter population (similarly to the Czech one) showed significant heterozygosity excess (assuming an infinite allele model) indicating recent population bottlenecks. A very recent population decline was also suggested by coalescent analysis, inferring a drop to ca. 25% of the past effective population size in both the Slovak and Czech populations (Hájková et al., 2007). In the last two decades an increase and a colonizing tendency of the population species range have been registered. The otter was distributed over the most of the Slovak territory, except the upper parts of high mountains (the highest altitudes of its occurrence in Slovakia were recorded in Nízke Tatry Mts., Západné Tatry Mts., Vysoké Tatry Mts. and Belianske Tatry Mts. - otter crossing over a mountain saddle at an altitude of 1600 - 1800 m a.s.l.) and some lowland areas in south-western and south-eastern Slovakia (e.g. Urban, 2010; Urban et al., 2010a, 2012; Figure 1).

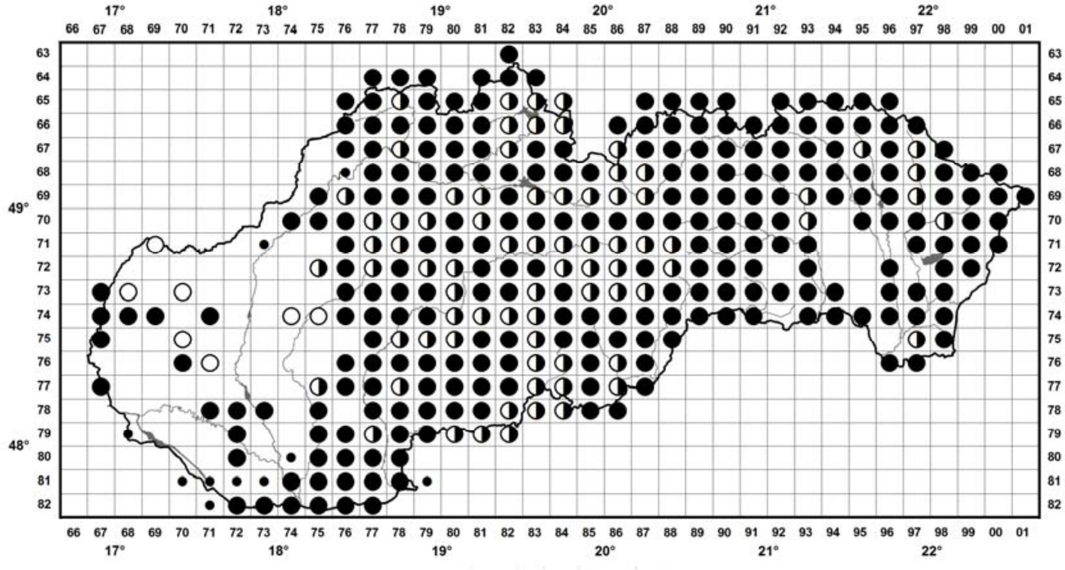



**Figure 1.** Recent Eurasian Otter distribution in Slovakia (Urban et al., 2012). Legend: big black circles - permanent occurrence since 1965; big empty circles - permanent occurrence till 1964; big black and empty circles - permanent occurrence till 1964 and since 1965, as well; small big circles - temporary occurrence.

A similar trend in otter population (decreasing and then increasing) took place in the Hron River catchment. Aquatic fauna of this river was strongly influenced by human activities between 1970-1985 (Sedlár et al., 1983a,b,c; Bitušík, 1997), though recently the anthropogenic impact has been decreasing (e.g. Bitušík et al., 2006; Bulánková and Némethová, 2007).

The first information on otter occurrence, otter hunting and fur processing in the middle part of the Hron River near Banská Bystrica was published by Matej Bel (Bel, 1736). In the middle of the 19th century, Kornhuber (1857) mentioned the occurrence of the otter in rivers and reservoirs, especially in the mountain forests of the HronRiver valley. In the vicinity of Banská Štiavnica (Hodrušská nádrž - reservoir) the species was observed at the end of 19th century by Petricskó (1892). According to historic hunting records, otters were still present (was hunted) throughout the Hron River catchment in the End of the 19th and in the early 20th century (Jamnický, 1995). In the beginning of the 20th century, Jirsík(1926) characterized the otter as a species occurring from lowlands up to 900–1000 m a.s.l. The otter occurrence nearthe waters of Zvolen district (in the middle part of the river) is reported by Ferianc (1949).

Most of the data on the otter distribution in Slovakia, including the Hron River catchment, from the beginning of the second half of 20$^{th}$ century are mainly obtained from national questionnaires (e.g. Podhradský, 1964; Hell and Cimbal, 1978; Hell, 1980). Their results are, however, influenced by a relatively high systematic and coincidental error, due to a small sample of respondents and their experience in identification signs of otter presence (Urban et al., 2010a, 2011). In the 1960ies there was an accomplished inquiry on otters in the pages of the hunters magazine Poľovníctvo a rybárstvo (Hunting and Fishing), the results of which were summarized by Podhradský (1964). These results were also used in the monograph of mammals of Slovakia (Feriancová-Masárová and Hanák, 1965). Otter occurred at the upper Hron River, between Závadka nad Hronom and Slovenská Ľupča and along its left tributary Slatina River (Figure 2). According to Chudík (1969), the otter occurred permanently between Telgárt and Bujakovo, near Brezno (at the upper river too).

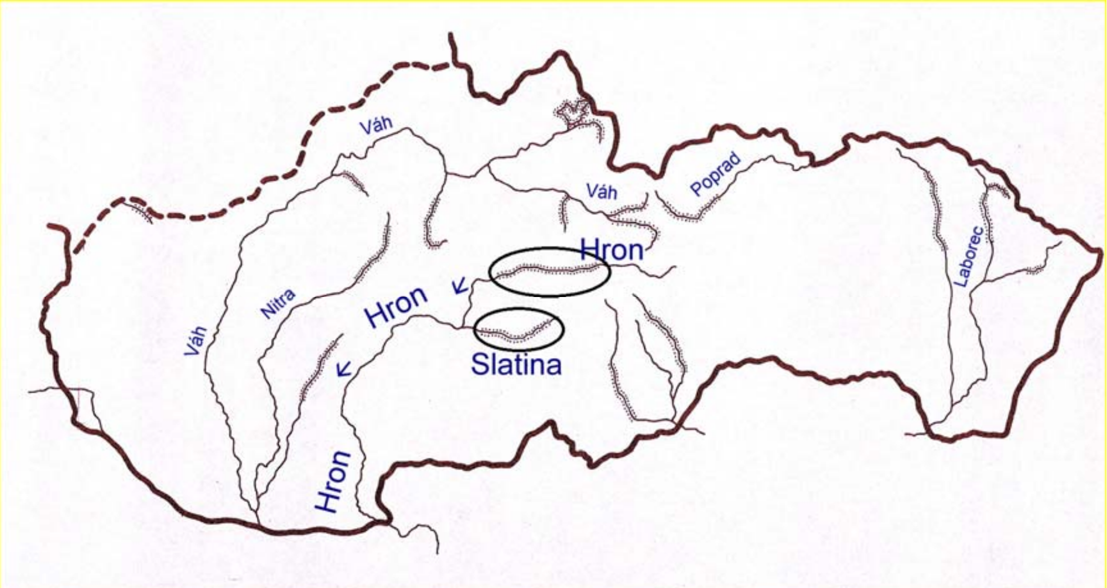



**Figure 2.** Eurasian otter distribution in Slovakia in 1965 (Feriancová-Masárová and Hanák, 1965). Legend: black dots - occurrence of the otter, circles - otter occurrence in the Hron River catchment.

The first nationwide investigation on the distribution of the otter in Slovakia was carried out in the 1970s by asking hunters for the number of otters living in their shooting-grounds (Hell and Cimbal, 1978). The evidence from these questionnaires indicated that the number of otters in the Hron river catchment was estimated to be 70 individuals on 485 km of watercourses and 50 ha of reservoirs and ponds (1 otter per 6.9 km$^2$).

In 1989, within the long-term programme of the otter research and conservation, called the “Action Otter”, a systematic study of the otter started (e. g. Kadlečík, 1990a,b, 1992; Kadlečík and Urban, 1997). Within this programme, regular otter survey and monitoring was carried out in the upper Hron river catchment (in the Poľana region, Low Tatras and Muránska planina plateau). Results from these activities showed that the otter occurred from meanders near Telgárt to Slovenská Ľupča, above Banská Bystrica (in upper Hron), including most of the tributaries, as well as all major streams in the Poľana Protected Landscape Area (PLA) (e.g. Kadlečík and Urban, 1997; Urban and Topercer, 1999). The upper Hron River between Telgárt and Bujakovo, near Brezno, was identified as one of the most important areas of the otter distribution in Slovakia (Kadlečík and Urban, 1997). However, the species was not found in the middle and lower parts of the Hron between Žiar nad Hronom and Bíňa (ca 110 - 130 km along the main stream) and in its tributaries during 1990-1997 period. The otter permanently occurred at a West-side tributary, Parížsky potok brook, with marshes and ponds and adjacent section from the Hron River, after its confluence with the Danube River, near Kamenica nad Hronom village (Kadlečík, 1998) (Figure 3).

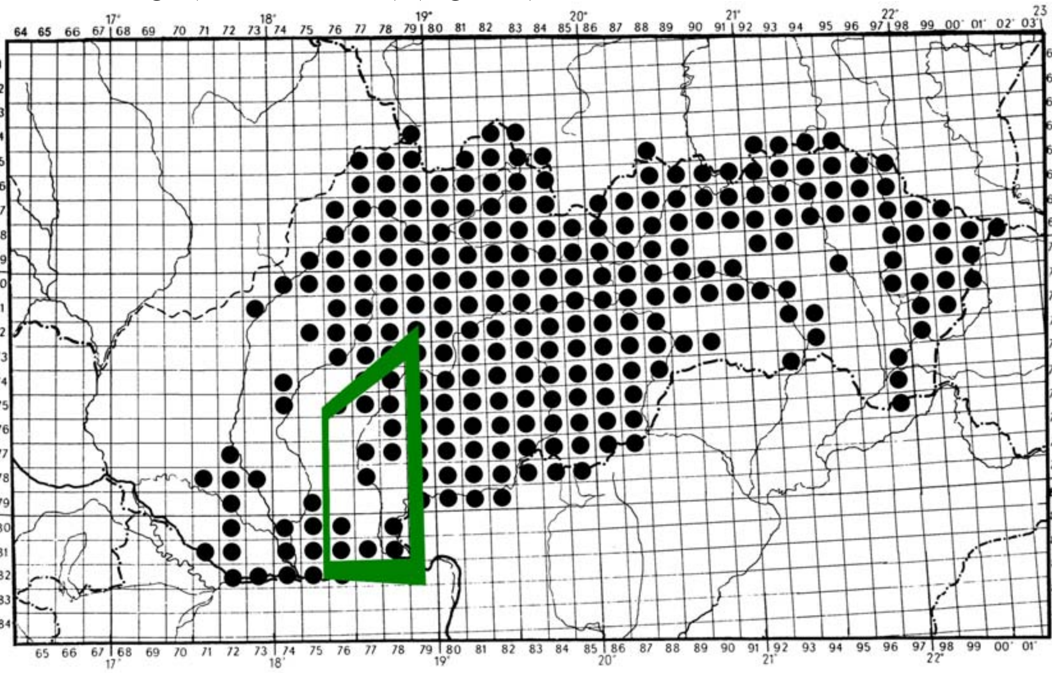


**Figure 3.** Eurasian otter distribution in the lower parts of the Hron River catchment in 1990s (Kadlečík and Urban, 1997). Legend: black circles – occurrence of the otter; green lines – lower part of the Hron River catchment.

Although a number of studies on the distribution and ecology of the otter have been carried out concerning the Hron River catchment (e.g. Urban, 1999; Urban and Topercer, 1999; Ramaj, 2008; Urban et al., 2011) none conducted a mapping of changes in otter distribution in the entire area.

The aim of this study was to summarize and compare the results from three otter surveys in the whole Hron River catchment.

## METHODS

### Study area

The Hron River is one of the main rivers on the West Carpathians. It is the second longest (length 297.4 km; catchment area- 5464.54 $km^2$), and one of the most important left side tributaries, of the Danube River in Slovakia with an average flow rate of 56 $m^3.s^{-1}$ near its confluence with the Danube (Figure 4). The source of the river is situated between the Nízke Tatry and Slovenský Raj Mountains at 934 m a.s.l. (Figure 5) and reaches the Danube River near the village of Kamenica nad Hronom (at 103 m a.s.l) (Figure 6). The upper and middle parts of the river lie in the submontane and colline belts of the Carpathian phytogeographical region. The lower part is situated in the planare belt of the Pannonian phytogeographical region but a major part of the river is regulated and affected by strong human activities (e.g. Urban et al., 2010b).

In the upper part of the river, heavy industry is absent and this habitat was included in the European network of Special Areas of Conservation - Natura 2000. The Hron river is contaminated by multiple sources of geogenic and anthropogenic origin since wood, petrochemical and mining industries are located in various sites through the catchment (Hiller et al., 2010). More serious pollution begins in Brezno and comes from urban settlements, such as Brezno, Podbrezová, Dubová and Slovenská Ľupča. In the middle stretch there are not only urban agglomerations (e.g. Banská Bystrica, Zvolen), but also an industrial one (aluminium factory in Žiar nad Hronom). In the downstream stretch, the biota in the river is negatively influenced by a water power station, urban wastewaters and significant eutrophication due to agriculture (e.g. Bulánková and Némethová, 2007; Urban et al., 2010b).

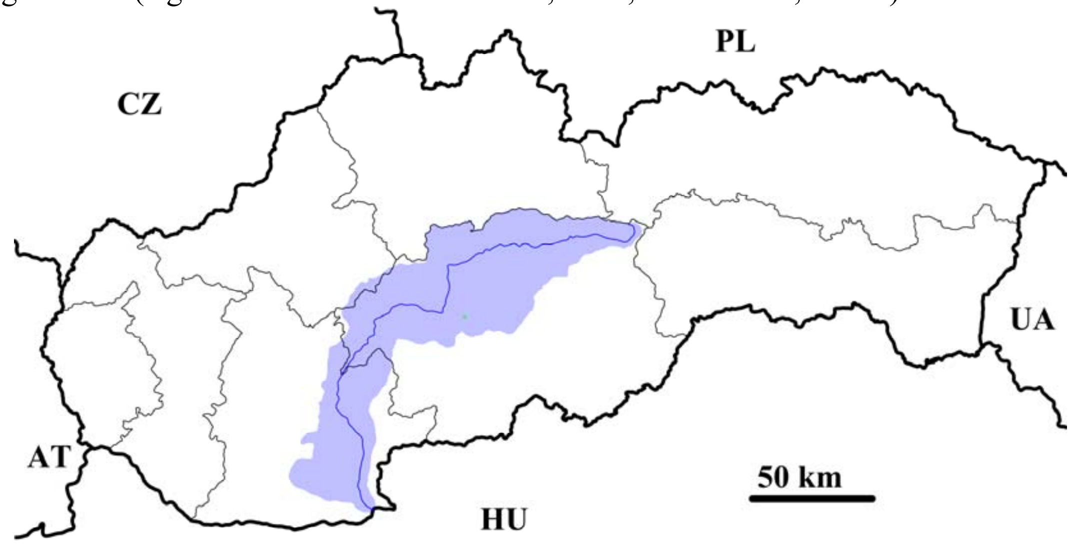



**Figure 4.** The Hron River catchment.
[Available at:
http://upload.wikimedia.org/wikipedia/commons/8/81/Hron_River_-_location_and_watershed_map.svg]

**Figure 5.** The source of the Hron River above the Telgárt village © Peter Urban.

**Figure 6.** The estuary of the Hron River in to the Danube River near Kamenica nad Hronom © Peter Urban.

## Field sampling

The modified standard IUCN/OSG method for monitoring of the Eurasian otter was used for three field censuses in the Hron River catchment. This involved searching for signs of presence of this species, such as footprints, anal gland secretions and spraints in a network of UTM grid quadrates (e.g. Reuther et al., 2000). During each census, 600 m long sections in 48 quadrates of the "Databank of Slovak Fauna (DSF)"(approx. 10×12 km) were checked for otter presence. These quadrants were subdivided into a higher resolution grid of 152 smaller quadrants (approx. 2.5×3km).)

The first survey was held in winter of 1995/1996. The second survey was carried out in summer and autumn of 2010 (during the third one-off otter mapping on the whole Slovak territory, e.g. Urban 2010, Urban et al., 2010a) and the third survey was performed in winter of 2011/2012. Spraints were rated in three categories - fresh (max. up to 5 days); medium (dry but yet intact, ca 6-14 days) and old (dry, several weeks old, compact or broken into components) (Bas et al., 1984, modified by Urban and Topercer, 2001). During each survey every spraint discovered was removed.

## RESULTS AND DISCUSSION

During the first survey 35 quadrants (72.9 %) and 73 quadrants (48.0 %) were positive for otter presence (Figure 7 and 8). During the second survey 45 quadrates (93.7 %) and116 quadrants (76.3%) (Figure 9 and 10). Similar to the previous mappings, the third mapping (in winter of 2011/2012) resulted in 45 positive quadrants (93.7 %) and 120 (78.9%) positive quadrants (Figure 11 and 12).

Results from the two regional surveys (2010, 2011/2012) documented an increase in percentage of positive quadrates and in range occupied by otters in the Hron River catchment compared to that in 1995/1996. The increase most pronounced in the central part of the catchment. Otters presently occur throughout the Hron River basin.

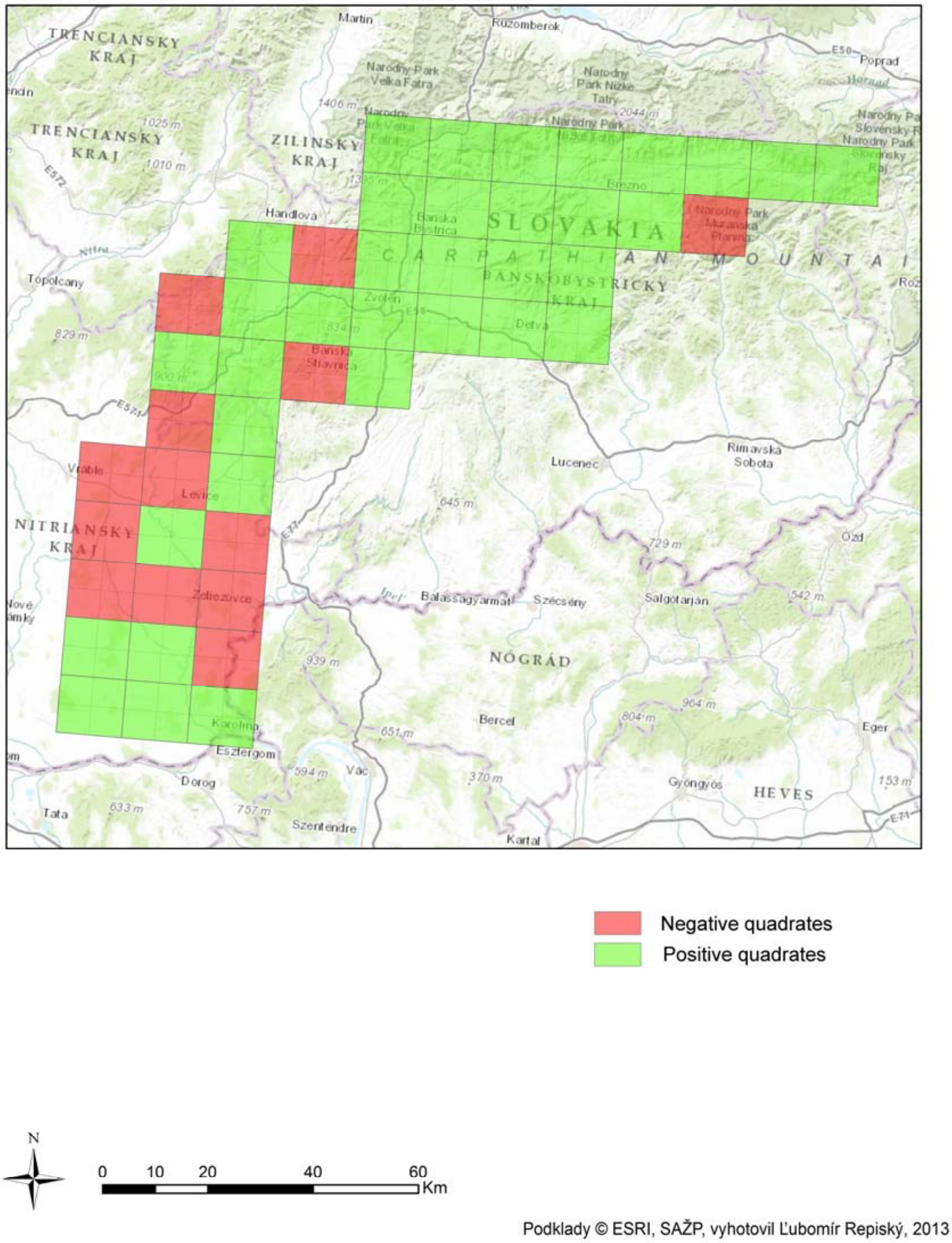



**Figure 7.** Overview results of the first otter mapping in the Hron River catchment (in winter 1995/1996) in the DSF quadrates. Author of the map © Ľubomír Repiský.

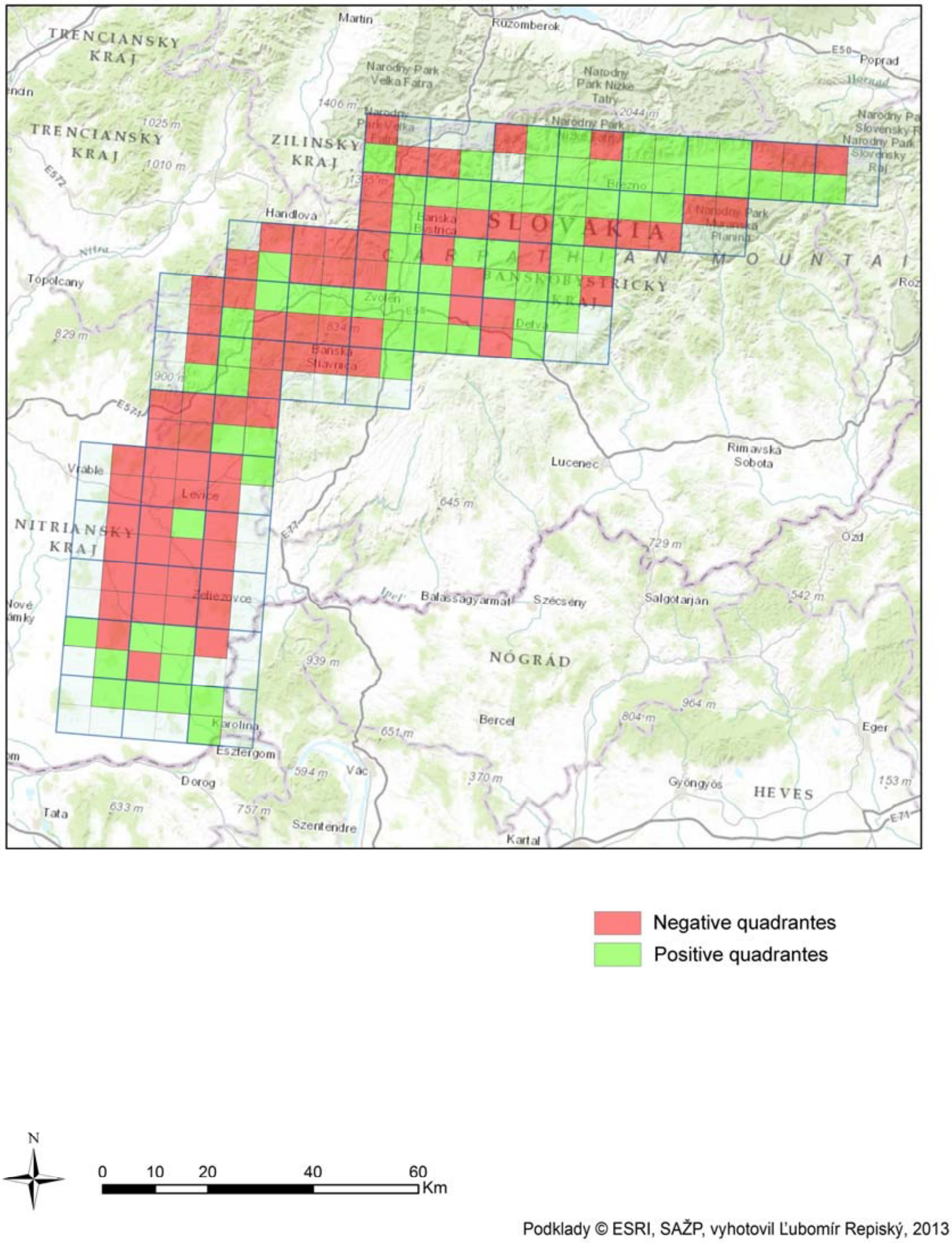



**Figure 8.** Detailed results of the first otter mapping in the Hron River catchment (in winter 1995/1996) in the DSF quadrates. Author of the map © Ľubomír Repiský.

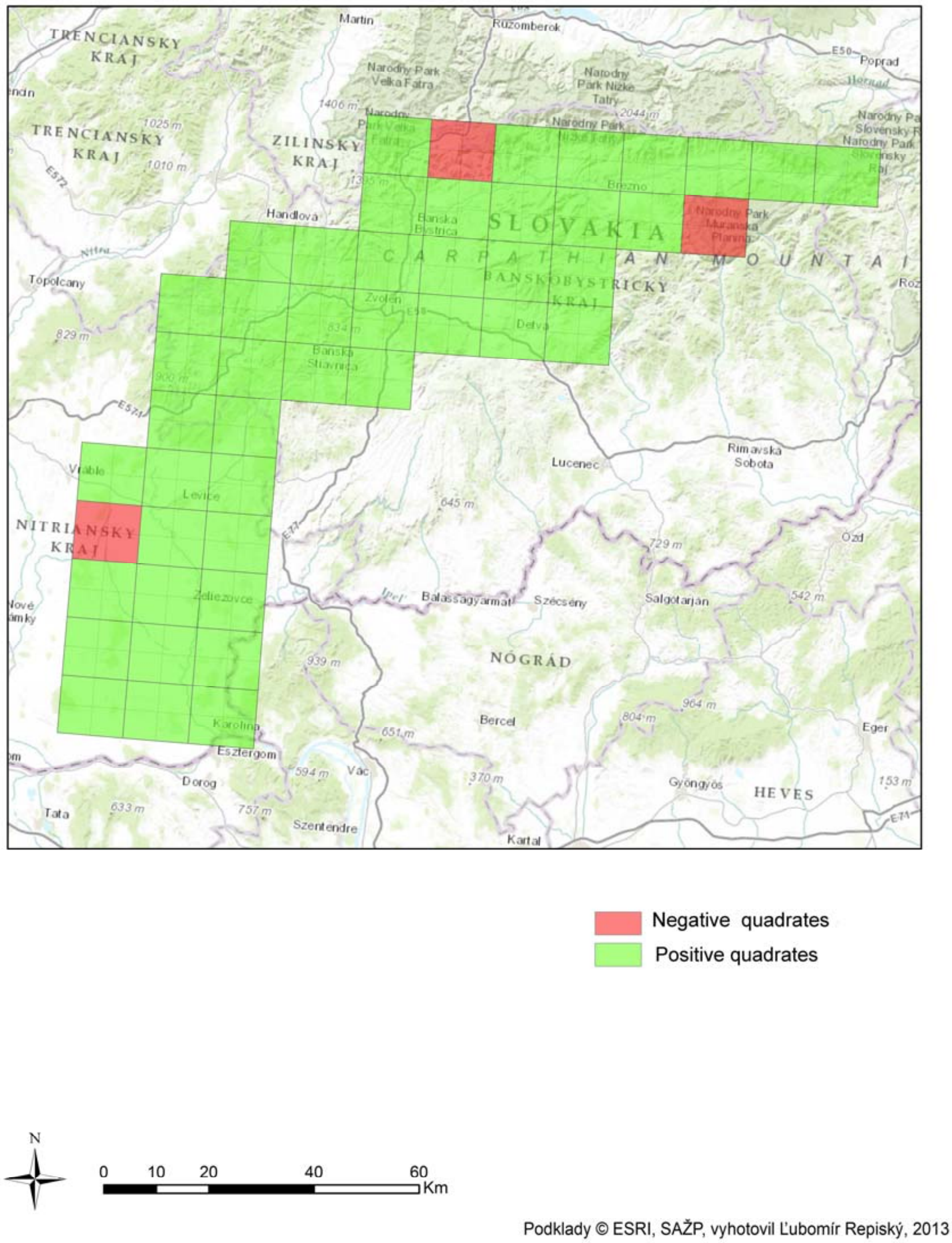



**Figure 9.** Overview results of the second otter mapping in the Hron River catchment (in summer and autumn of 2010) in the DSF quadrates. Author of the map © Ľubomír Repiský.

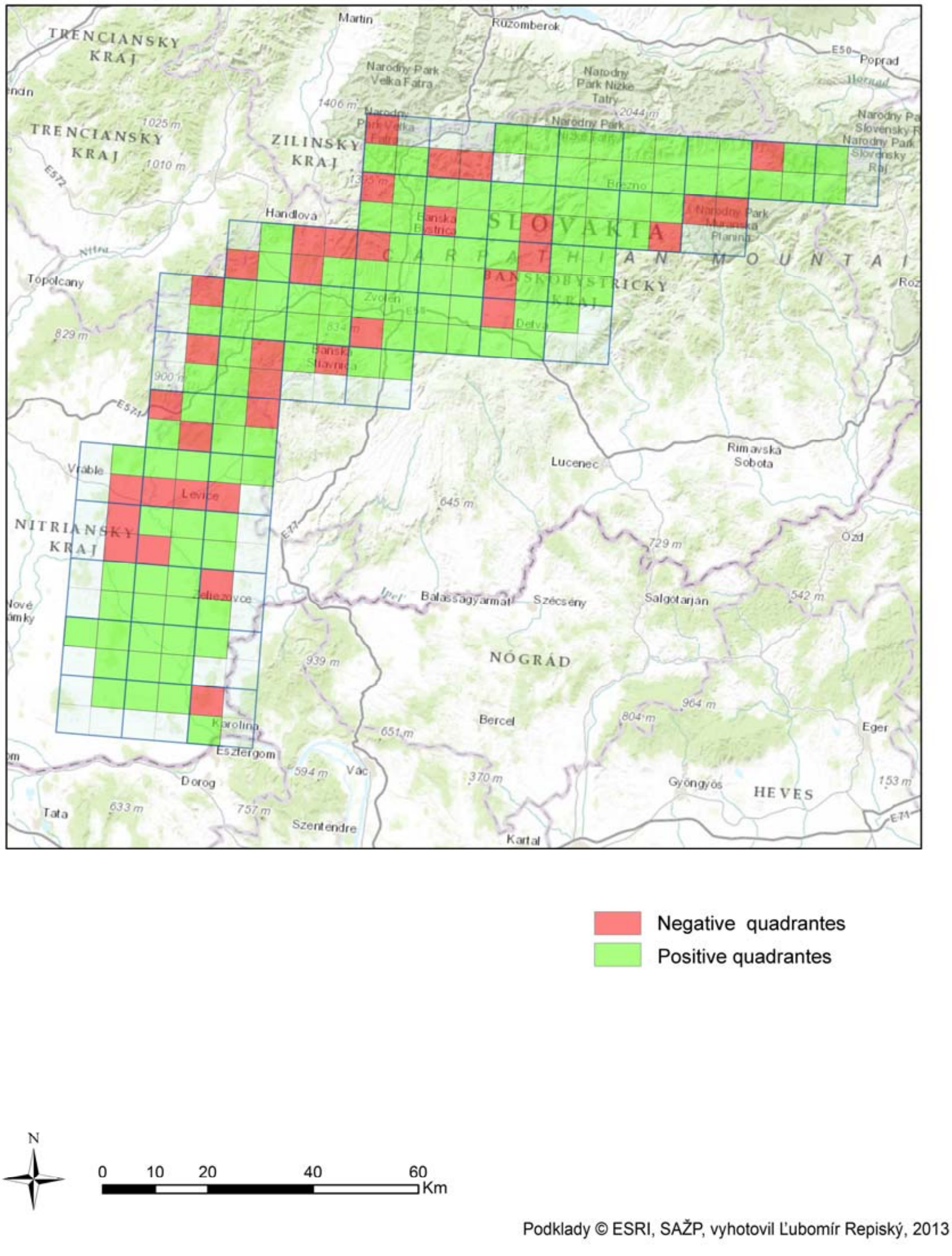



**Figure 10.** Detailed results of the second otter mapping in the Hron River catchment (in summer and autumn of 2010) in the DSF quadrates. Author of the map © Ľubomír Repiský.

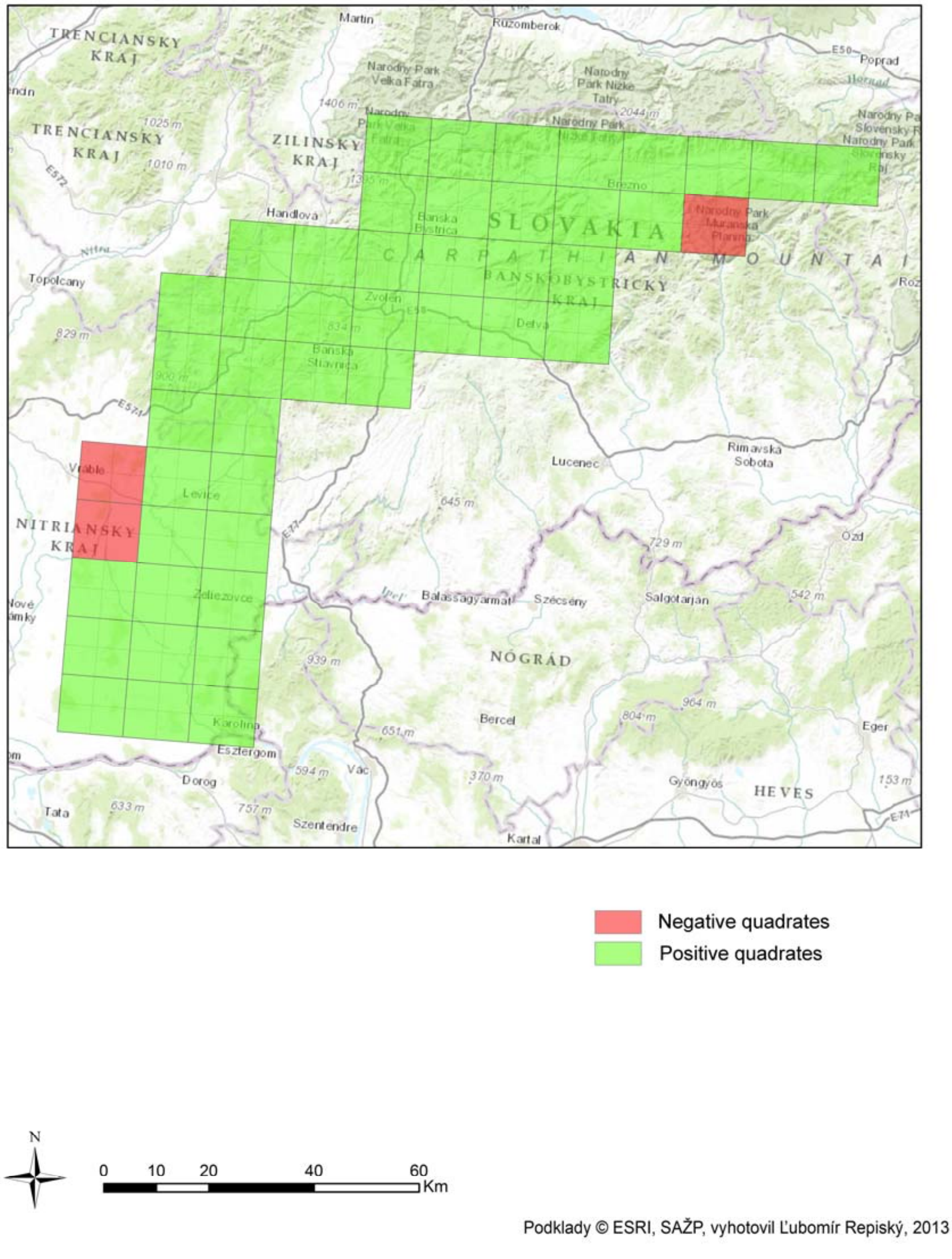



**Figure 11.** Overview results of the third otter mapping in the Hron River catchment (in winter of 2011/2012) in the DSF quadrates. Author of the map © Ľubomír Repiský.

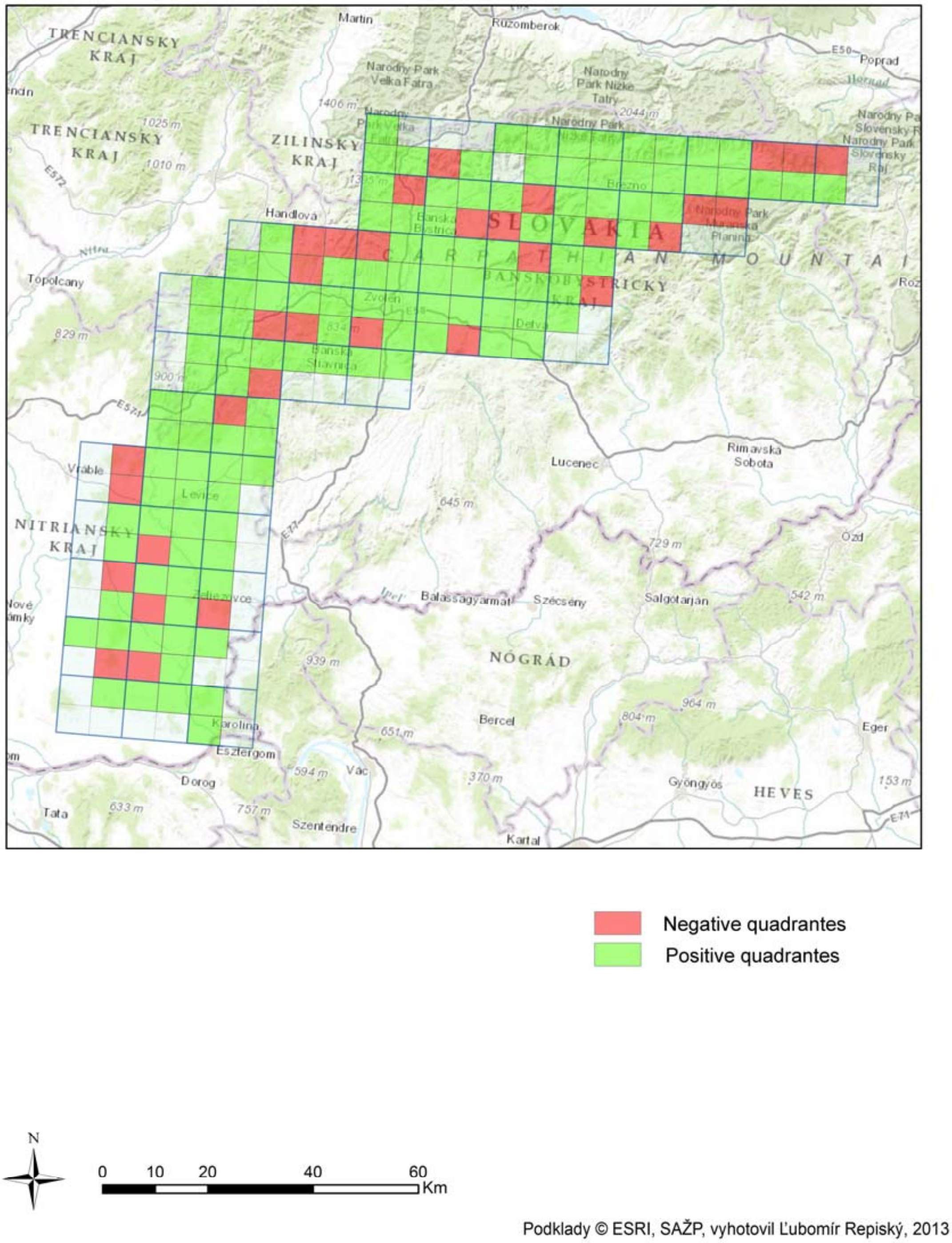



**Figure 12.** Detailed results of the third otter mapping in the Hron River catchment (in winter of 2011/2012) in the DSF quadrates. Author of the map © Ľubomír Repiský.

Water pollution had probably a major impact on the otter distribution and abundance in the Hron River catchment. Water quality in this river basin is largely influenced by the settlement of peoples and his lifestyle, especially by use of landscape for agricultural purposes and production of waste water in the settlements and industrial effluents and higher consumption of water resources. The Hron River was enormous permanently polluted (especially by industrial effluents) during the 1960s and 70s of the 20-th centuries. Pollution completely excludes fish life in the middle part of the river (Pekárová and Szolgay, 2005). The rapid increase of pollution in the1970s (e.g. the period 1972-1976 was consider as the upper limit of the stream pollution at sampling site Šalková, near Banská Bystrica) is followed by gradual improvement of the surface water quality in next period (Sedlár et al., 1983a,b,c; Pekárová et al., 2004). The Hron River catchment is one of the most used areas in Slovakia from the view point of water-management balance. In the second half of seventies a rapid development of industrialization and economic and urban activities affected the area of water consumption. This had negative effect on the total decrease of water bearing capacity in the entire length of the river, besides other natural impacts. The timing of permanently pollutions and water consumption correlates with the period when the otter population in Slovakia decline and indicated recent population bottleneck (Hájková, 2007; Hájková et al., 2007). The situation in the overall pollution of the Hron River in the 1980s and 1990s of the 20$^{th}$ century was gradually improved. Reducing the quantities of pollutants from agriculture and industry, and building of a wastewater treatment plants has improved the situation, so that through intensive restocking returned fish life in the middle Hron until Žiar nad Hronom (Pekárová and Szolgay, 2005). Fish populations have been re-established by programs of intensive stocking in the Hron River basin, principally from Podbrezová to Žiar nad Hronom (Mužík, 2013).

A similar situation was also recorded for aquatic invertebrates (e.g. Bitušík et al. 2006; Krno, 2007; Illéšová et al., 2008). Compared chironomid assemblages with data from 1980s when the zonation pattern was largely influenced by pollution stress (Bitušík, 1997), the present data support the longitudinal interpretation scheme of the river (Bitušík et al., 2006).

The upper stretch of the Hron River to Slovenská Ľupča achieves recent high or good ecological status. The middle and lower stretches of the Hron River achieve moderate ecological status as well as poor chemical status (Anonymous, 2009). In spite of the relatively high human impact in lowland part of the Hron River, habitat diversity in whole river course is still very high (Bulánková, 2006). The main pollutants in the chemical status category are phthalates - the most commonly used plasticizers and lead (Pb). The majority of water bodies in the river basin (73.0 %) achieve good or high ecological status, only 27.0 % of the water bodies in the river basin are failing to achieve good status (Anonymous, 2009).

In general, otter abundance and densities are higher, while their homerange sizes are inversely related to the river width (Sidorovich et al., 1996; Ó Néill et al., 2009; Romanowski et al., 2013), which is mainly a consequence of the higher fish productivity in larger rivers. In very small watercourses, otters are usually only occasional visitors (Romanowski et al., 2013).

A new survey conducted in the Hron River catchment, in 2008-2010, revealed that seasonal distribution of spraint numbers was bimodal, showing a maximum in autumn and spring and the minimum in the summer. Of the 180 habitat variables sampled at 137 sites, multiple logistic regression indicated positive relationships between spraint numbers and otter distribution with the percentage of stones suitable for sprainting in the channel, distance to the nearest human settlement, and negative relationships to the average depth and width of the channel, percentage of trees in the riparian vegetation and intensity of human intrusions. The strength and significance of all relationships varied seasonally, most markedly with stream the velocity and the percentage of trees in the riparian vegetation (Urban et al., in prep.). Riparian vegetation and habitat quality is one of the most important drivers of the large-scale recovery of the otter for several reasons: it provides resting and breeding dens, provides cover during movements, enhances filtering of pollutants, and promotes fish productivity (e. g. Jenkins and Burrows, 1980; Green et al., 1984; Elmeros et al., 2006; Clavero et al., 2010; Romanowski et al., 2013).

The main food source for otters is fish, which differ in composition between the upper and the lower section of the river, yet species richness is similar (e. g. Kruuk et al., 1993; Jeņdrzejewska et al., 2001; Lanszki and Sallai, 2006; Loy et al., 2009; Urban et al., 2010b).

The major constraint on otter populations in West Sussex was food availability with fish and amphibians forming the major part of their diet (e.g. Kruuk et al., 1988; Jacobsen and Hansen, 1996; Chanin, 2003). Fish and eel movements along the river were hindered by barriers such as weirs (King, 2011). Until the turn of the century, on the main flow of the Hron River there were already a small number of barriers, such as weirs (e.g. Lopej, Zvolen) and dams (the Veľké Kozmálovce reservoir with an area of 0.62 $km^2$ and a total water volume of $2.7 \times 10^6$ $m^3$) (Figure 13). In the last 20 years about 10 new small hydropower plants have been built (Figure 14). In the Hron River were 22 transverse structures without fishpass in operation in 2009 and the construction of 30 new small hydropower plants on the Hron River is being considered.

**Figure 13.** Veľké Kozmálovce water reservoirs © Peter Urban

The Environmental Impact Assessment (EIA) in the Slovak Republic is carried out since 1994, when the Act No. 127/1994 Coll on EIA came into effect. In 2006 it was replaced with the Act No. 24/2006 Coll on EIA. The Eurasian Otter is listed in Annex II and IV of the Habitats Directive 92/43/EEC that involves obligations to developers within the EU. According to the Habitats Directive the otter population and its habitats, including corridors connecting local populations, must be considered in the EIA throughout the EU territory and not only in the Special Areas of Conservation (SACs). In most EIA projects there were no proposed mitigation or compensation measures designed particularly for otters, and there were no studies dealing with otters. In the future it will be needed to make the EIA process in Slovakia more appropriate, *inter alia*, with regard to otters and other animal species (Urban et al., 2010a).

**Figure 14.** Hronská Dúbrava small hydroelectric power plant was built in 2011 © Peter Urban

Recent studies indicate that the recovery of the otter is accompanied by a change in habitat selection (e.g. Romanowski, 2006; Clavero et al., 2010). Habitat features that limit the species expansion are, amoung others, the presence of large towns or hydroelectric dams, and important reduction of the river flow, (e. g. Ruiz-Olmo et al., 1991; Saavedra 2002). In the middle flow of the Hron River is the conurbation Banská Bystrica (ca. 80.000 people) - Zvolen (ca. 70.000 people). In both cities, the river was regulated, but the otter occurs throughout the year.

In general, otter were seen to re-colonize habitats with low quality too, such as regulated river sections, river sections in agricultural landscape with large blocksof fields, or in industrialized areas (e. g. Green and Green, 1997; Romanowski, 2006, Romanowski et al, 2013). In the Hron River catchment area 137 localities were checked (Figure15)., These, fell into 17 different CORINE land cover classes out of the 31 landclasses which were identified for the entire territory of Slovakia (Feranec and Oťahel, 2001). The most representative types were the Discontinuous urban fabric (25 localities, 18.3%), Broad-leaved forests (16 localities, 11.7%) and Coniferous forests (11 localities, 8.0%) (Urban et al., in prep.). Similar results were obtained from Scotland, where an increasing otter population recolonized a relatively polluted and industrialized area (Green and Green, 1997) and in Poland where otters were often detected in low-quality habitats (e. g., regulated river sections) (Romanowski et al., 2013). Wide distribution of otter signs in various types of riparian habitats, including those strongly transformed by human activity, may be an indicator of a thriving and numerous population (Baltrūnaitė et al., 2009).

The negative side-effect of the otter expansion is the increase of fish-stock damages in the Hron River and its tributaries as well as in small fish ponds located in the catchment. As a consequence, fishpond owners are increasingly seeking damage compensation or permits for shooting otters (similar to the cormorant, *Phalacrocorax carbo*). Information about the impact of otters on fish assemblages and stocks is therefore of considerable interest especially to ichthyologists and nature conservationists.

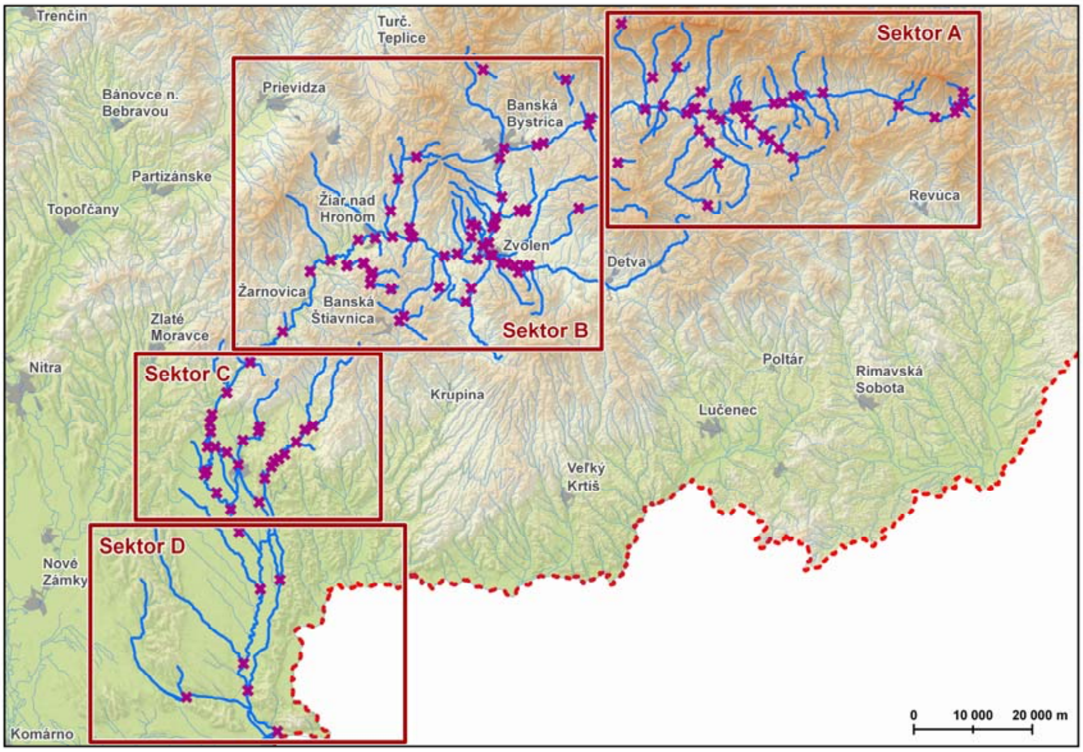



**Figure 15.** Overview of checked localities in the Hron river catchment. Author of the map © Michal Klaučo

Problems, which are connected to the occurrence of the otter and fishery, are becoming increasingly important (Kučerová et al., 1996). One of the reasons, why this is so, is the increasing density of otter populations and recolonisation of the habitats, mainly in areas with ponds (e.g. Kemenes and Nechay, 1990; Kemenes, 1991; Bodner, 1995a) and along rivers, which are used by fishing organisations (e. g. Carss et al., 1990; O'Neill, 1998; Ludwig et al., 2002; Poledník et al., 2004 ). The recent increase in otter numbers has resulted in a typical human-wildlife conflict due to significant damages by otter spredating on commercial fishstocks, particularly at farmed fishponds (e.g. Kloskowski, 2005; Kranz et al., 1999; Myšiak et al., 2004). Eurasian otter and managed fisheries in Central Europe, mostly carp (*Cyprinus carpio*) production, is another example of a widely studied conflict, focusing on otter diet (e.g. Bodner, 1995a,b; Kučerová 1996, 1998; Gossow and Kranz, 1998; Kloskowski, 1999, 2000a,b, 2005; Adámek et al., 2003; Lanszki and Molnár, 2003; Lanszki et al., 2001; Jacobsen, 2005; Poledník, 2005; Baltrūnaitė, 2009; Kloskowski 2011), biological indicators of stress (e.g. Poledník et al., 2008), damage assessment (e.g. Skaren, 1990; Bodner, 1995b, 1998; Gossow and Kranz, 1998; Kloskowski, 2005; Poledník, 2005), damage prevention (e.g. Bodner, 1995b; Gossow and Kranz, 1998; Leblanc, 2003; Kloskowski 2011; Klenke et al., 2013; Poledníková et al., 2013) and compensation schemes (e.g. Gossow and Kranz, 1998; Freitas et al., 2007;

Schwerdtner and Gruber, 2007; Kloskowski 2011; Václavíková et al., 2011; Poledníková et al., 2013; Santos-Reis et al., 2013; Klenke et al., 2013). This type of biological and socio-economic information is critical for rescue management, conflict resolution and species conservation (Sales-Luis et al., 2009). Damage compensation schemes are widely used to mitigate human–wildlife conflicts. Despite the growing relevance of such conflicts, a theoretical framework to analyze the cost-effectiveness of damage compensation schemes is still missing (e.g. Schwerdtner and Gruber, 2007).

Compensation of damages caused by otters in the Slovak Republic is legally established in the Act No. 543/2002 on Nature and Landscape Protection and in the Decree No. 24/2003 to this act. According to this Act the state is responsible for damages caused by otters on the fish raised for commercial purposes in fishponds or in aquaculture facilities. It is possible to provide compensation if the otter probably occurs at the time and place of the recorded damages. Funding for compensations is provided by the Ministry of Environment of the Slovak Republic from the state budget through the Regional Offices of Environment. According to the Act no. 543/2002 on nature and landscape protection it is not possible to enforce the compensation of damages in open waters. However there is increasing pressure from the Slovak Anglers Association (Slovenský rybársky zväz) to deal with the problem of fishery in mountain and submountain rivers and streams (trout waters) with otters.

Fishermen also claim that the reintroduction of otters by nature conservation (state organisations and NGO-s too) helps its spread in the Hron River. Reintroductions of extinct or endangered and nearly extinct species are becoming nowadays a more accepted tool for the restoration of biodiversity (Seddon, 2010). Reintroduction of otters supports otter conservation as confirmed by the results of discussions and controversies some time ago (e.g. De Jongh, 1998; Reuther, 1998). The reintroduction through translocation of wild animals has been chosen because it is desirable (IUCN, 1998). In Europe, reintroduction programs of the Eurasian otter started in the 1980s in England (lowland English rivers: Jefferies et al., 1986, 2000; Wayre, 1989, 1992; Jessop and Cheyne, 1992; Strachan and Jefferies, 1996; Copp and Roche, 2003; White et al., 2003) and Sweden (Sjöåsen and Sandegren, 1992; Sjöåsen, 1996, 1997), where newly established populations seemed to be spreading. More recently, the otter has been successfully reintroduced in some countries. We have examples of this in the Czech Republic (Jeseníky Mts.: Hlaváč et al. 1998; Toman et al., 2003; Poledníková et al., 2010), France (Rosoux et al., 1996; Fidenci, 2010), Italy (Ticino River: Prigioni, 1995; Prigioni et al., 2009), the Netherlands (Lammertsma et al., 2006; Koelewijn et al., 2010; Seignobosc et al., 2011) and north-eastern Spain (Girona's province: Saavedra and Sargatal, 1998; Mateo et al., 1999; Fernández-Morán et al. 2002; Saavedra, 2002; Ferrando et al., 2008). In West European countries, reintroduction programs in the areas where otters have been extinct are developed after restoration of natural otter habitats and improving water quality (Koelewijn et al., 2010; Romanowski et al., 2013).

In the Czech Republic the otter was reintroduced in the Jeseníky Mountains in 1994–2003. The aim was to connect the south-Bohemian population with the strong Slovak or "east-European" population and thus prevent possible decrease in genetic variability in the future (Hlaváč, 1995; Hlaváč et al., 1998). After the introduction of legislative protection, several management actions and general improvement of riverine habitats, the otter population has recovered and the species currently occupies most of its historical range (Poledník et al., 2007).

In Slovakia, reintroduction of otters has not yet been carried out, because it was not necessary and otters naturally colonized not only Hron River, but also other rivers, especially their middle sections. However, otter shave been released into the wild after successful rehabilitation in a few cases (e.g. in Váh and Orava rivers - in northern Slovakia).

The negative attitude towards otters persists and their illegal killing remains a common practice in Slovakia. Despite the general prohibition of hunting protected animals in Slovakia the cases of shooting, striking death or catching otters in traps or fyke nets are also common and an indication of insufficient public awareness (Urban et al., 2010a). With the increased economical use of waters the otter has become understood as a competitor to man and the voices for the control of its population have been raised. This supports poaching, the extent of which however is difficult to assess (Kadlečík, et al. 2009; Urban et al., 2010a). With the increased economical use of waters, the otter has become identified as a competitor to man and voices for the control of its population have been raised. This supports poaching, the extent of which, however, is difficult to assess (Kadlečík et al., 2009).

Otter road kills are currently among the most important recorded reasons of its mortality in the Hron River catchment. For example, in the sections of the I. class road between Banská Bystrica and Brezno as well as Brezno and Telgárt (ca 90 km), along the upper Hron River, we registered 23 killed otters between 2005-2010 (Urban et al., 2011).

The otter is in the Hron River catchment protected in 11 Special Areas of Conservation (Natura 2000) - in both biogeographical Regions in Slovakia (Alpine and Pannonian): Alúvium Hrona, Pohorelské vrchovisko, Bacúšska jelšina, Kráľovohoľské Tatry, Ďumbierske Tatry, Veľká Fatra, Vtáčnik, Skalka, Suť, Klokoč, Hodrušská hornatina, 3 national parks (Nízke Tatry, Muránska planina and Veľká Fatra) and 3 protected landscape areas (Poľana, Štiavnické vrchy, Ponitrie). To protect the habitats of otters some small-scale protected areas have been designated, e.g. Protected Site (PS) Kamenistý potok.

Other protected areas, set up to protect valuable wetland communities and localities, include the most valuable sections of the otter home range, e.g. National Nature Reserve (NNR) Meandre Hrona and Parížske močiare.

## CONCLUDING REMARKS

Answer to the question who reintroduced the Otter in the Hron River and why is very easy and briefly: nobody, because it was not necessary. The otter has expanded its distribution range in the Hron River catchment in the last two decades. This spread probably related with improvement of the surface water quality in 1980s and 1990s and with the overall increase in species range and numbers of otters in other parts of Slovakia, simultaneous to the similar recolonization processes in several European (and neighboring) countries (e.g. Kranz et al., 2001; Prigioni et al., 2007; Poledníková et al., 2010; Romanowski et al., 2013).

However, as the West Carpathian and Hercynian otter populations experienced a population decline of unknown extent over the past century, their genetic polymorphism and effective population size may have been depleted, making them vulnerable to any strong demographic change (Hájková et al., 2007).

**Acknowledgements –** I would like to thank to colleagues and students, Martin Benda, Peter Bitušík, Anton Krištín, Zuzana Kubíková, Dušan Malatinec, Stanislav Ondruš, Erika Urbanová, Ivan Valach, for their assistance, or help with the fieldwork. I also thank to Ľubomír Repiský and Michal Klaučo for preparation of maps. I am grateful to Ladislav Hamerlík for proofreading. This study was supported by the VEGA Grant Agency of the Slovak Republic (grant numbers 1/0836/08 and 2/5083/25) and KEGA Grant Agency of the Slovak Republic (grant number KEGA 001UMB-4/2012).

## REFERENCES

**Adámek, Z., Kortan, D., Lepic, P., Andreji, J. (2003).** Impacts of otter (*Lutra lutra*) predation on fishponds: a study of fish remains at ponds in the Czech Republic. *Aquaculture* **11**: 389-396.

**Anonymous (2009).** Status of waters and water management issues in the River basins of the Slovak Republic. Water Research Institute, Bratislava.

**Baltrūnaitė, L. (2009).** Diet of Otters in Fish Farms in Lithuania. *Acta Zoologica Lituanica* **19**(3): 182-187.

**Baltrūnaitė, L., Balčiauskas, L., Matulaitis, R., Stirkė, V. (2009).** Otter distribution in Lithuania in 2008 and changes in the last decade. *Estonian Journal of Ecology* **58**: 94–102.

**Bas, N., Jenkins, D., Rothery, P. (1984).** Ecology of otters in northern Scotland. The distribution of otter (*Lutra lutra*) faeces in relation to bankside vegetation on the river Dee in summer 1981. *Journal of Applied Ecology* **21(**2): 507-513.

**Bel, M. (1736).** Notitia Hungariae novae historico–geographica. Tomus II. J.P. van Ghelen, Vienna. Available at: [http://oldbooks.savba.sk/digi/].

**Bitušík, P. (1997).** The use of chironomid pupal exuviae (Diptera: Chironomidae) for characterizing of the river Hron (Slovakia, West Carpathians). *Acta Facultatis Ecologiae* **4**: 61-76.

**Bitušík, P., Svitok, M., Dragúňová, M. (2006).** The actual longitudinal zonation of the river Hron (Slovakia) based on chironomid assemblages (Diptera, Chironomidae). *Acta Universitatis Carolinae Biologica* **50**: 5-17.

**Bodner, M. (1995a).** Fish loss in Austrian fish-pond as result of otter (*Lutra lutra*) predation. *IUCN Otter Spec. Group Bull.* **12**: 3–10.

**Bodner, M. (1995b).** Otters and fish-farming: preliminary experiences of a WWF project in Austria. *Hystrix* **7**(1-2): 223–228.

**Bodner, M. (1998).** Damage to stock in fish ponds as a result of otters (*Lutra lutra*) predation. *BOKU-Reports on Wildlife Research & Game Management* **14**:106-117.

**Bulánková, E. (2006).** Hodnotenie riečnej morfológie Hrona pomocou metódy River Habitat Survey. *Acta Fac. Ecol*. **14**: 39–45.

**Bulánková, E., Némethová, D. (2007).** Linkages between Land-Use, Water Quality, Physical Habitat Conditions and Selected Macroinvertebrate Assemblages of the Hron River (Slovakia). *Acta Universitatis Carolinae Environmentalica* **21** (2007): 35-46.

**Carss, D.N., Kruuk, H., Conroy, J.W.H. (1990).** Predation on adult Atlantic salmon, *Salmo salar* L., by otters, *Lutra lutra* L., within the River Dee system, Aberdeenshire, Scotland. *Journal of Fish Biology* **37**: 935-944.

**Chanin, P. (2003).** Ecology of the European Otter (*Lutra lutra*): Conserving Natura 2000 Rivers. Ecology Series No. 10. English Nature, Peterborough.

**Chudík, I. (1969).** Príspevok k poznaniu rozsiahlosti lovišťa vydry riečnej na horských riekach Slovenska. *Československá ochrana prírody.* **8**: 149-158.

**Clavero, M., Hermoso, V., Brotons, L., Delibes, M. (2010).** Natural, human and spatial constraints to expanding populations of otters in the Iberian Peninsula. *J. Biogeogr.* **37**: 2345-2357.

**Copp, G. H., Roche, K. (2003).** Range and diet of Eurasian otters *Lutra lutra (L.)* in the catchment of the River Lee (south-east England) since re-introduction. *Aquatic Conservation: Marine and Freshwater Ecosystems* **13**(1): 65-76.

**De Jongh, A.W.J.J. (1998).** Re-introduction of otters - support or risk for otter conservation? *IUCN Otter Spec. Group Bull.* **15:** 80-86.

**Elmeros, M., Hammershøj, M., Madsen, A.B., Søgaard, B. (2006).** Recovery of the otter *Lutra lutra* in Denmark monitored by field surveys and collection of carcasses. *Hystrix. It. J. Mamm. (n. s.)* **17**: 17-28.

**Feranec, J., Oťahel, J. (2001).** Krajinná pokrývka Slovenska. Land cover of Slovakia. Veda, Bratislava.

**Ferianc O. 1949.** Fauna Zvolenskéhookresu so zreteľom na stavovce. *Prírodvedný sborník SAV, Bratislava.* **4**: 37-76.

**Feriancová–Masárová, Z., Hanák, V. (1965).** Stavovce Slovenska 4. Cicavce.Vydavateľstvo Slovenskej akadémie vied, Bratislava.

**Fidenci, P. (2010).** A slow comeback for the endangered Eurasian otter in France. Mongabay. Available at: [http://news.mongabay.com/2010/0829-fidenci_otters.html].

**Fernández-Morán J., Saavedra, D., Manteca-Vilanova, X. (2002).** Reintroduction of the Eurasian otter (Lutra lutra) in northeastern Spain: trapping, handling, and medical management. *Journal of Zoo and Wildlife Medicine* **33**(3): 222-227.

**Ferrando, A., Lecis, R., Domingo-Roura, X., Ponsà, M. (2008).** Genetic diversity and individual identification of reintroduced otters (*Lutra lutra*) in north-eastern Spain by DNA genotyping of spraints. *Conservation Genetics* **9**(1): 129-139.

**Freitas, J., Gomes, J., Sales Luis, T., Madruga, L., Marques, C., Baptista, G., Rosalino, L. M., Antunes, P., Santos, R., Santos-Reis, M. (2007).** Otters and fish farms in the Sado estuary: ecological and socio-economic basis of a conflict. *Hydrobiologia* **587** (1): 51-62.

**Gossow, H., Kranz, A. (eds.). (1998).** Otters and Fish Farms. Proceedings International Workshop Litschau, 8.-9. Feb. 1996 (Austria). *Boku-Reports on Wildlife Research & Game Management* **14**: 1-144 pp.

**Green, J., Green, R., Jefferies, D.J. (1984).** A radio-tracking survey of otters *Lutra lutra* on a Perthshire river system. *Lutra* **27**: 85-145.

**Green, R., Green, J. (1997).** Otter survey of Scotland 1991–94. Vincent Wildlife Trust, London.

**Hájková, P. (2007).** Genetická štruktúra a recentný pokles početnosti populácií vydry riečnej v ČR a SR. *Bulletin Vydra* **14**: 50–57.

**Hájková, P., Pertoldi, C., Zemanová, B., Roche, K., Hájek, B., Bryja, J., Zima J. (2007).** Genetic structure and evidence for recent population decline in Eurasian otter populations in the Czech and Slovak Republics: implications for conservation. *Journal of Zoology, London* **272**: 1-9.

**Hell, P. (1980).** Die Situation des Fischotters in der ČSSR. pp. 195–198. In**: Reuther, C., Festetics, A. (eds.):** Der Fischotter in Europe. Verbreitung, Bedrohung, Erhaltung. Ergebnisse des I. Internationalen Fischotter-Kolloquiums vom 28. bis 31. Oktober 1979 in Göttingen. Selbstverlag, Oderhaus und Göttingen.

**Hell, P., Cimbal, D. (1978).** Rozšírenie a početnosť vydry riečnej (*Lutra lutra* L.) na Slovensku. *Folia venatoria* **8**: 223-236.

**Hiller, E., Jurkovič, Ľ., Šutriepka, M. (2010).** Metals in thre Surface Sediments of Selected Water Reservoirs, Slovakia. *Bull. Environ. Contam.Toxicol.* **84**: 635-640.

**Hlaváč, V. (1995).** Příprava reintrodukčního projektu v oblasti Jeseníků. *Bulletin Vydra* **5**: 2–3.

**Hlaváč, V., Toman, A., Boděšínský, M. (1998).** Experimentální reintrodukce vydry v Jeseníkách. *Bulletin Vydra* **8**: 27-39.

**Illéšová, D., Halgoš, J., Krno, I. (2008).** Blackfly assemblages (Diptera, Simuliidae) of the Carpathian river: habitat characteristics, longitudinal zonation and eutrophication. *Hydrobiology* **598**(1): 163-174.

**IUCN (1998).** IUCN Guidelines for re-introductions. Gland, Switzerland.

**Jacobsen, L. (2005).** Otter (*Lutra lutra*) predation on stocked brown trout (*Salmo trutta*) in two Danish lowland rivers. *Ecology of Freshwater Fish* 14(1)0: 59-68.

**Jacobsen, L., Hansen, H.M. (1996).** Analysis of otter (*Lutra lutra*) spraints: Part 1: Comparison of methods to estimate prey proportions; Part 2: Estimation of the size of prey fish. *Symp. Zoological Society London* **238**: 167-180.

**Jamnický, J. (1995).** Lov vydry riečnej (*Lutra lutra* L.) na Slovensku pred sto rokmi. *Folia Venatoria* **25**: 189-194.

**Jefferies, D. J., Wayre, P., Jessop, R. M., Mitchell-Jones, A. J. (1986).** Reinforcing the native otter *Lutra lutra* population in East Anglia: an analysis of the behaviour and range development of the first release group. *Mammal Rev*. **16:** 65-79.

**Jefferies, D. J., Wayre, P., Shuter, R. (2000).** A brief history of the Otter Trust's successful programme of repopulating lowland England with otters bred in captivity with a special emphasis on East Anglia. *Otters, Journal of the Otter Trust* **3**(4): 105-117.

**Jeņdrzejewska, B., Sidorovich, V. E., Pikulik, M. M., Jeņdrzejewski, W. (2001).** Feeding habits of the otter and American mink in Białowieża Primeval Forest (Poland) compared to other Eurasian populations. *Ecography* **24**: 165-180.

**Jenkins, D., Burrows, G. O. (1980).** Ecology of otters in northern Scotland. 3. The use of faeces as indicators of otter (*Lutra lutra*) density and distribution. *J. Anim. Ecol.* **49**: 755-774.

**Jessop, R.M., Cheyne, D.L. (1992).** The re-introduction of the European otter*Lutra lutra* in to Lowland England carried out by the Otter Trust 1983-92. A progress report. Proceeding of the National Otter Conference, Cambridge, September, 1992, pp: 12-16.

**Jirsík, J. (1926).** Přehled slovenských savců. *Věstník Československé společnosti zemědělských věd* **30**: 1-8.

**Kadlečík, J. (1990a).** Akcia Vydra a jej poslanie. *Bulletin Vydra* **1**: 3-9.

**Kadlečík, J. (1990b).** Zahájenie Akcie Vydra. *Bulletin Vydra* **1**: 10-12.

**Kadlečík, J. (1992).** Rozšírenie vydry riečnej (*Lutra lutra* L., 1758) na Slovensku - súčasný stav poznania. *Bulletin Vydra* **3**: 54-59.
**Kadlečík, J. (1998).** Poznámky k rozšíreniu vydry riečnej (Lutra lutra) v oblastiach priľahlých k riekam Morava a Dunaj v rokoch 1994-1998. *Bulletin Vydra*, **8**: 17-22.
**Kadlečík, J., Urban, P. (1997).** Vydra riečna (*Lutra lutra* L.) na Slovensku a jej ochrana. *Folia venatoria* **26–27**: 111-129.
**Kadlečík, J., Urban, P., Kadlečíková, Z., Adamec, M. (2009).** Program záchrany vydry riečnej (*Lutra lutra* Linnaeus, 1758). Aktualizácia pre obdobie rokov 2009 – 2013. ŠOP SR, Banská Bystrica (msc.). [Depon. In: State Nature Conservancy of the Slovak Republic, Banská Bystrica].
**Kemenes, I. (1991).** Otter distribution, status and conservation problems in Hungary. *IUCN Otter Spec. Group Bull.* **6**: 20–23.
**Kemenes, I., Nechay, G. (1990).** The food of otters (*Lutra lutra*) in different habitats in Hungary. *Acta Theriologica* **35**(1–2): 17–24.
**King, P. (2011).** Routes of recolonisation of the Eurasian otter (*Lutra lutra)* into West Sussex: An investigation of optimum ways to restore a viable ecological network to assist their recovery to the South East, with particular reference to the Western Rother Valley. People´s trust for endangered species.
**Klenke, R. A., Ring, I., Kranz, A., Jepsen, N., Rauschmayer, F., Henle, K. (2013).** Human - Wildlife Conflicts in Europe Fisheries and Fish-eating Vertebrates as a Model Case. Springer, Heidelberg, New York, Dordrecht, London.
**Kloskowski, J. (1999).** Otter *Lutra lutra* predation in cyprinid-dominated habitats. *Zeitschrift für Säugetierkunde* **64**: 201-209.
**Kloskowski, J. (2000a).** Selective predation by otters *Lutra lutra* on common carp *Cyprinus carpio* at farmed fisheries. *Mammalia* **64**: 287-294.
**Kloskowski, J. (2000b).** The distribution of otter *Lutra lutra* spraints in relation to habitat exploitation in a fish-pond area, South-East Poland. *Lutra* **43**:19-28.
**Kloskowski, J. (2005).** Otter *Lutra lutra* damage at farmed fisheries in southeastern Poland, II: exploitation of common carp Cyprinus carpio. *Wildlife Biology* **11**: 257-261.
**Kloskowski, J. (2011).** Human–wildlife conflicts at pond fisheries in eastern Poland: perceptions and management of wildlife damage. *European Journal of Wildlife Research* **57**(2): 295-304.
**Koelewijn, H.P., Pérez-Haro, M., Jansman, H.A.H., Boerwinkel, M.C., Bovenshen, J., Lammertsma, D.R., Niewold, F.J.J., Kuiters, A.T. (2010).** The reintroduction of the Eurasian otter (*Lutra lutra*) into the Netherlands: hidden life revealed by noninvasive genetic monitoring. *Conserv. Genet.***11**: 601–614.
**Kornhuber, G. A. (1857)**. Synopsis der Säugethiere mit besonderer Beziehung auf deren Vorkommen in Ungarn. Druck von K. F. Wigand, Presburg.
**Kranz, A. (1999).** Re-Introduction of Otters: A Reply. *IUCN Otter Spec. Group Bull.* **16** (1): 8-10.
**Kranz, A., Polednik, L., Pinter, V., Parz-Gollner, R. (2001).** Distribution, status and conservation of otters in Lower Austria. *Wiss. Mitt. Niederösterr. Landesmuseum* **14**: 39-50.
**Krno, I. (2007).** Impact of human activities on stonefly (Insecta, Plecoptera) ecological metrics in the Hron River (Slovakia). *Biologia, Bratislava* **62(**4): 446-457.
**Kruuk, H., Carss, D.N., Conroy, J.W.H., Gaywood, M.J. (1988).** Habitat use and conservation of otters *Lutra lutra* in Britain: a review. *Symp. Zoological Society London* **71**: 119-134.
**Kruuk, H., Carss, D. N., Conroy, J. W. H., Durbin, L. (1993).** Otter (*Lutra lutra*) numbers and fish productivity in rivers in North-East Scotland. *Symp. Zoological Society London* **65**: 171–191.
**Kučerová, M. (1996).** Economic damages caused by otters. pp. 97–103. In: Dulfer, R., Roche, K. (eds), First phase report of the Třeboň Otter Project. *Nature and Environment* **93**: 1-141.
**Kučerová, M. (1998).** Diet and damages by otters *Lutra lutra* on a series of private ponds in southern Bohemia (Czech Republic). Pp. 83–88. In: **Gossow, H., Kranz, A.** (eds.), Otters and Fish Farms. Proceedings International Workshop Litschau, 8.-9. Feb. 1996 (Austria). *Boku-Reports on Wildlife Research & Game Management* **14**: 1-144 pp.
**Lammertsma, D., Niewold, F., Jansman, H.,Kuiters, L., Koelewijn, H. P., Perez Haro,M., van Adrichem, M., Boerwinkel, M. C., Bovenschen, J. (2006).** Herintroductie van de otter: eensucces verhaal? *De Levende Natuur* **107**: 42-46.
**Lanszki, J., Molnár, T. (2003).** Diet of otters in three different habitats in Hungary. *Folia Zoologica* **52**: 378–388.
**Lanszki, J., Sallai, Z. (2006).** Comparison of the feeding habits of Eurasian otters on a fast flowing river and its backwater habitats. *Mamm. Biol.* **71**: 336-346.

**Lanszki, J., Körmendi, S., Hancz, C., Martin, T.G. (2001).** Examination of some factors affecting selection of fish prey by otters (*Lutra lutra*) living by eutrophic fish ponds. *Journal of Zoology (London)* **255**: 97-103.

**Leblanc, F. (2003).** Protecting fish farms from predation by Eurasian otter (*Lutra lutra*) in the Limousin region of central France: first results. *IUCN Otter Spec. Group Bull.* **20**(1):45-48.

**Loy, A., Carranza, M. L., Cianfrani, C., D'Alessandro, E., Bonesi, L., Di Marzio, P., Minotti, M., Reggiani, G. (2009).** Otter *Lutra lutra* population expansion: assessing habitat suitability and connectivity in southern Italy. *Folia Zool* .**58** (3): 309-326.

**Ludwig, G.X., Hokka, V., Sulkava, R., Ylönen, H. (2002).** Otter *Lutra lutra* predation on farmed and free-living salmonids in boreal freshwater habitats. *Wildl. Biol.* **8**: 193-199.

**Mateo, R., Saavedra, D., Guitart, R. (1999).** Reintroduction of the Otter (*Lutra lutra*) into Catalan Rivers, Spain: Assessing Organochlorine Residue Exposure Through Diet. *Bulletin of Environmental Contamination and Toxicology* **63**(2): 248-255.

**Mužík, V. (2013).** Slovakia – factors influencing recreational fisheries. Available at: [http://www.fao.org/docrep/005/w0318e/W0318E15.htm].

**Myšiak, J., Schwerdtner, K., Ring. I. (2004).** Comparative analysis of the conflicts between carp pond farming and the protection of otters (*Lutra lutra*) in Upper Lusatia and South Bohemia. UFZ-Discussion Papers. Department of Economics, Sociology and Law (OEKUS). UFZ Centre for Environmental Research Leipzig-Halle GmbH.

**O'Neill, E.M., Day, K.R., Paterson, J.P.H. (1998).** Predation by otters (*Lutra lutra*) at a salmon hatchery, evidenced by diet studies. *Boku-Reports on Wildlife Research & Game Management* **14**: 46-64.

**Ó Néill, L., Veldhuizen, T., de Jongh, A., Rochford, J. (2009).** Ranging behaviour and socio-biology of Eurasian otters (*Lutra lutra*) on lowland mesotrophic river systems. *Eur. J. Wildl. Res.* **55**: 363–370.

**Pekárová, P., Szolgay, J. (2005).** Scenáre zmien vybraných zložiek hydrosféry a biosféry v povodí Hrona a Váhu v dôsledku klimatickej zmeny. Veda, vydavateľstvo SAV, Bratislava.

**Pekárová, P.,Miklánek, P., Rončák, P., Adámková, J., Chriašteľ, R., Metelková, M., Pekár, J. (2004).** Identification and assessment of long-term trends of surface water quality determinands in Slovakia for implementation of the EU WFD. *J. Hydrol. Hydromech*. **52**(4): 317-328.

**Petricskó, J. (1892).** Selmeczbánya vidéke állattani tekintetben. (Selmeczbánya monografiája, Természettudományi rész II. füzet). Selmeczbánya.

**Podhradský, V. (1964).** Na záver ankety o výskyte vydry na Slovensku. *Poľovníctvo a rybárstvo* **16**: 15-16.

**Poledník, L. (2005).** Otters (*Lutra lutra* L.) and fishponds in the Czech Republic: interactions and consequences. PhD. thesis. Department of zoology and anthropology, Faculty of Science, Palacky University Olomouc, 109 pp. (msc.). [Depon. In: Faculty of Science, Palacky University Olomouc ].

**Poledník, L., Poledníková, K., Hlaváč, V. (2007).** Rozšíření vydry říční (*Lutra lutra*) v České republice v roce 2006. *Bulletin Vydra***14**: 4-6.

**Poledník, L., Mitrenga, R., Poledníková, K., Lojkásek, B. (2004).** The impact of methods of fishery management on the diet of otters (*Lutra lutra*). *Folia zoologica* **53**: 27-36.

**Poledník, L., Řehulka, J., Kranz, A., Poledníková, K., Hlaváč, V., Kazihnitková, H. (2008).** Physiological responses of over-wintering common carp (*Cyprinus carpio*) to disturbance by Eurasian otter (*Lutra lutra*). *Fish Physiology and Biochemistry* **34**(3): 223-234.

**Poledníková, K., Poledník, L., Hájková, P., Zemanová, B., Větrovcová, J., Hlaváč, V., Beran, V., Čamlík, G., Mináriková, T. (2010).** Struktura, dynamika a růst populace vydry říční (*Lutra lutra* L.) v České republice. Projekt SP/2d4/16/08. Unpubl. Report. Ministry of Environment, Praha.

**Poledníková, K., Kranz, A., Poledník, L., Myšiak, J. (2013).** Otters Causing Conflicts. pp. 81-106. In: **Klenke, R.A., Ring, I., Kranz, A., Jepsen, N., Rauschmayer, F., Henle, K.** (eds.), *Human - Wildlife Conflicts in Europe.* Fisheries and Fish-eating Vertebrates as a Model Case. Springer, Heidelberg, New York, Dordrecht, London.

**Prigioni, C. (1995).** Guidelines for the feasibility study of reintroduction of the otter *Lutra lutra* in Italy: the project of the Ticino Valley (north-western Italy). In: Prigioni C. (ed.), Proc. II It. Symp. on Carnivores, *Hystrix It. J. Mamm. (n.s.)* **7** (1-2): 225-264.

**Prigioni, C., Balestrieri, A., Remonti, L. (2007).** Decline and recovery in otter Lutra lutra populations in Italy. *Mammal. Rev.* **37**: 71-79.

**Prigioni, C., Smiroldo, G., Remonti, Balestrieri, A. (2009).** Distribution and diet of reintroduced otter (*Lutra lutra*) on the River Ticino (NW Italy). *Hystrix It. J. Mamm. (n.s.)* **20** (1): 45-53.

**Ramaj, M. (2008).** Monitoring vydry riečnej (*Lutra lutra*) na vybraných tokoch Národného parku Nízke Tatry, stredné Slovensko (Carnivora: Mustelidae). *Lynx (Praha), n. s.,* **39** (1): 129–142.

**Reuther, C. (1998).** Re-introduction of otters - support or risk for otter conservation?*IUCN Otter Spec. Group Bull.* **15**: 71-79.

**Reuther, C., Dolch, D., Green, R., Jahrl, J., Jefferies, D., Krekemeyer, A., Kucerova, M., Madsen, A.B., Romanowski, J., Roche, K., Ruiz-Olmo, J., Teubner, J. and Trinidae, A. (2000).** Surveying and monitoring distribution and population trends of the European otter (*Lutra lutra*). *Habitat* **12**: 1-148.

**Romanowski, J. (2006).** Monitoring of the otter recolonisation of Poland. *Hystrix. It. J. Mamm. (n.s.)* **17**: 37-46.

**Romanowski, J., Brzeziński M., Żmihorski, M. (2013).** Habitat correlates of the Eurasian otter *Lutra lutra* recolonizing Central Poland. *Acta Theriologica* **58**:149-155.

**Rosoux, R., Tournebize, T., Maurin, L., Bouchardy, C. (1996).** Étude de la répartition de la loutre d'Europe (*Lutra lutra*) en France. Actualisation 1993. In: La Loutre et le Vison d'Europe. (Edited by **Gautier, J.Y., Libois, R., Rosoux, R.**) (Proceedings of the XVIIth International Mammalogical Conference, Niort, 23-25 October 1993.) *Cahiers d'Ethologie appliqué,* **15**: 195-206.

**Ruiz-Olmo, J., Jimenez, J., Lacomba, I. (1991).** Length of hydrographical basins and population viability of the otter in rivers in Eastern Spain. *Habitat* **6**: 255-258.

**Saavedra, D. (2002).** Reintroduction of the Eurasian otter (*Lutra lutra*) in Muga and Fluvià basins (north-eastern Spain): viability, development, monitoring and trends of the new population. PhD Thesis, Girona, University, 217 pp.

**Saavedra, D., Sargatal, J. (1998).** Reintroduction of the otter (*Lutra lutra*) in northeast Spain (Girona Province). *Galemys* **10**:191–199.

**Sales-Luis, T., Freitas, D., Santos-Reis, M. (2009).** Key landscape factors for Eurasian otter *Lutra lutra* visiting rates and fish loss in estuarine fish farms. *European Journal of Wildlife Research* **55**(4): 345-355.

**Santos-Reis, M., Santos, R., Antunes, P., Sales-Luís, T., Gomes, J., Freitas, D. , Madruga, L. (2013).** Reconciliation of the Conflict between Otters and Fish Farmers. Pp: 49-79. In: **Klenke, R. A., Ring, I., Kranz, A., Jepsen, N., Rauschmayer, F., Henle, K.** (eds.), *Human - Wildlife Conflicts in Europe.* Fisheries and Fish-eating Vertebrates as a Model Case. Springer, Heidelberg, New York, Dordrecht, London.

**Schwerdtner, K., Gruber,B. (2007).** A conceptual framework for damage compensation schemes. *Biological Conservation* **134**(3): 354-360.

**Seddon, P. J. (2010).** From reintroduction to assisted colonization: moving along the conservation translocation spectrum. *Restoration Ecology* **18** (6): 796-802.

**Sedlár, J., Straňai, I., Makara, A. (1983a).** Súčasný stav zarybnenia povodia Hrona. *Poľnohospodárstvo* **29(**6): 515-524.

**Sedlár, J., Straňai, I., Makara, A. (1983b).** Súčasný stav zarybnenia povodia Hrona. *Poľnohospodárstvo* **29** (7): 619-627.

**Sedlár, J., Straňai, I., Makara, A. (1983c).** Súčasný stav zarybnenia povodia Hrona. *Poľnohospodárstvo* **29** (8): 684-701.

**Seignobosc, M., Hemerik, L., Koelewijn, H. P. (2011).** A demo-genetic analysis of a small reintroduced carnivore population: the otter (*Lutra lutra*) in The Netherlands. International Journal of Ecology. Volume 2011, Article ID 870853, 11 pp., doi:10.1155/2011/870853.

**Sidorovich, V, Jędrzejewska, B, Jędrzejewski, W. (1996).** Winter distribution and abundance of mustelids and beavers in the river valleys of Bialowieża Primeval Forest. *Acta Theriol.***41**:155-170.

**Sjöåsen, T. (1996).** Survivorship of captivebred and wild-caught reintroduced European otters (*Lutra lutra*) in Sweden. *Biological Conservation* **76**: 161-165.

**Sjöåsen, T. (1997).** Movements and establishment of reintroduced European otters *Lutra lutra*. *Journal of Applied Ecology* **34**: 1070-1080.

**Sjöåsen, T., Sandegren, F. (1992).** Reintroduction of Eurasian otters (*Lutra lutra*) in southern Sweden 1987-1992: a project in progress. *Habitat* **7**: 143-146.

**Skáren, U. (1990).** Fish farming and otters in Finland. *IUCN Otter Spec. Group Bull.* **5**: 28-34.

**Strachan, R., Jefferies, D. J. (1996).** The Otter Survey of England 1991-1994. The Vincent Wildlife Trust, London.

**Toman, A., Roche, M., Roche, K., (2003).** Reintroduction of otters in the Czech Republic. The Return of the Otter in Europe – Where and How? International Otter Conference, Isle of Skye (30. June-4. July 2003).

**Urban, P. (1999).** K ekológii vydry riečnej (*Lutra lutra* L.) na Slovensku. Dizertačná práca. Ústav ekológie lesa SAV, Zvolen, 106 pp. (MSc). [Depon. In: Ústav ekológie lesa SAV, Zvolen].

**Urban, P. (2010).** The Eurasian otter in Slovakia - A preliminary report from a survey. *IUCN Otter Spec. Group Bull.* **27** (3): 148-157.

**Urban, P., Kadlečík, J. (2001).** Program záchrany chráneného ohrozeného druhu vydra riečna *Lutra lutra* (Linnaeus, 1758). Štátna ochrana prírody Slovenskej republiky Banská Bystrica, 20 pp. (MSc.). [Depon. In: State Nature Conservancy of the Slovak Republic, Banská Bystrica]. Available at: [http://www.sopsr.sk/cinnost/programy/PZ%20Lutra%20lutra.pdf]

**Urban, P., Topercer, J. (1999).** Rozšírenie, početnosť a životné podmienky vydry riečnej v širšejoblastiPoľany. *Ochrana prírody* **17**: 189–208.

**Urban, P., Topercer, J. (2001).** K značkovaciemu správaniu vydry riečnej (*Lutra lutra L.*) na strednom Slovensku. *Folia venatoria* **30–31**: 207-224.

**Urban, P., Kadlečík, J., Topercer, J., Kadlečíková (2010a).** Eurasian otter (*Lutra lutra* L.) in Slovakia. Distribution, biology, risks and conservation. Faculty of Natural Sciences, Matthias Belius University, Banská Bystrica.

**Urban, P., Hrivnák, R., Oťaheľová, H., Weis, K. (2010b).** Aquatic macrophyte vegetation and its relationship to the occurrence of the Eurasian otter (*Lutra lutra*) in the Hron River (Slovakia). *IUCN Otter Spec. Group Bull.* **27** (3): 158-165.

**Urban, P., Kadlečík, J., Topercer, J., Kadlečíková, Z., Hájková, P. (2011).** Vydra riečna (*Lutra lutra* L.) na Slovensku. Rozšírenie, biológia, ohrozeniea ochrana. Fakulta prírodných vied UMB, Banská Bystrica.

**Urban, P., Kadlečík, J., Kadlečíková, Z. (2012).**Vydra riečna – *Lutra lutra*. In: **Krištofík, J., Danko, Š. (eds.).** Cicavce Slovenska, rozšírenie, bionómia a ochrana. Veda, Bratislava: 440-447.

**Václavíková, M., Václavík, T., Kostkan, V. (2011).** Otters vs. fishermen: Stakeholders' perceptions of otter predation and damage compensation in the Czech Republic. *Journal for Nature Conservation* **19**(2): 95-102.

**Wayre, P. (1989).** History and known results of the Otter Trust re-introduction programme in England 1983-1989. *Otters, Journal of the Otter Trust* **2**(3): 26-27.

**Wayre, P. (1992).** The first twenty-one years of the Otter Trust and its re-introduction program. *Otters, Journal of the Otter Trust* **6**:17-22.

**White, P.C.L., Mc Clean, C.J., Woodroffe, G.L. (2003).** Factors affecting the success of an otter (*Lutra lutra*) reinforcement programme, as identified by post-translocation monitoring. *Biological Conservation* **112**: 363-371.

## RÉSUMÉ

## RECOLONISATION DE LA LOUTRE (*Lutra lutra*) SUR LA RIVIERE HRON (SLOVAKIA) – RESULTAT PRELIMINAIRE D'UNE ENQUETE OU QUI A REINTRODUIT LA LOUTRE SUR LA RIVIERE HRON ET POURQUOI ?

La loutre d'Europe (*Lutra lutra*) est largement répartie en Slovaquie. La population de cette espèce a nettement diminuée au cours du 20è siècle. Au cours des deux dernières décennies, une augmentation et une tendance colonisatrice de l'aire de répartition ont été enregistrées. Une tendance similaire a eu lieu dans le bassin versant de la rivière Hron. La méthode standard et modifiée de L'UICN/OSG pour le suivi de la population de Loutre d'Europe a été utilisée en trois cessions de terrain sur l'aire de distribution de la loutre dans le bassin versant de la rivière Hron. Les résultats ont été obtenus sous deux résolutions, l'une sur une grille de 10×12 km issue de la banque de données de la faune slovaque soit 48 carrés, et une résolution plus élevée résultant de la subdivision de la première grille correspondant alors à 152 carrés d'environ 2,5×3 km. Lors de la première enquête (hiver 1995/1996) 35 quadrats (72,9%) et 73 quadrants (48,0%) étaient positifs. Au cours de la deuxième enquête (en été et à l'automne 2010) 45 quadrats (93,7%), ou 116 quadrats (76,3%) ont été trouvés positifs. Au cours de la troisième cartographie (hiver 2011/2012) 45 quadrats et 120 quadrats (78,9%) ont été positifs. Les résultats de deux enquêtes régionales récentes (2010, 2011/2012) ont présenté une augmentation du pourcentage de sites positifs et un élargissement de la surface occupée dans le bassin versant de la rivière Hron par rapport à celle de 1995/1996. L'augmentation a été plus marquée dans la partie centrale du bassin versant et probablement liée à l'amélioration de la qualité des eaux de surface dans les années 1980 et 1990.

**RESUMEN**

**RE-COLONIZACIÓN POR LA NUTRIA EUROASIÁTICA (*LUTRA LUTRA)* EN LA CUENCA DEL RÍO HRON (ESLOVAQUIA) - INFORME PRELIMINAR DE UNA PROSPECCIÓN, O ¿QUIÉN RE-INTRODUJO LA NUTRIA EN EL RÍO HRON, Y POR QUÉ?**

La nutria euroasiática (*Lutra lutra*) está ampliamente distribuida en Eslovaquia. La población de esta especie disminuyó marcadamente durante el siglo 20. En las últimas dos décadas se ha registrado un aumento y una tendencia de colonización del rango de distribución de la especie. Una tendencia similar tuvo lugar en la cuenca del Río Hron. Para realizar tres censos de terreno de la distribución de la nutria en la cuenca del Río Hron, se utilizó el método standard de UICN/OSG para monitorear poblaciones de Nutria Euroasiática. Se obtuvieron los resultados en dos resoluciones, una grilla de aproximadamente 10x12 km del "Banco de Datos de Fauna Eslovaca (DSF)", correspondiendo a 48 cuadrículas, y una resolución más alta resultante de la subdivisión de la grilla ya mencionada, correspondiendo a 152 cuadrantes de aproximadamente 2.5x3 km. Durante la primera prospección (invierno de 1995/1996), fueron positivas 35 cuadrículas (72.9 %) y 73 cuadrantes (48.0 %). Durante la segunda prospección (verano y otoño de 2010), se encontraron positivas 45 cuadrículas (93.7 %), o 116 cuadrantes (76.3 %). Durante el tercer mapeo (invierno de 2011/2012), fueron positivas 45 cuadrículas y 120 cuadrantes (78.9 %). Los resultados de las dos prospecciones regionales recientes (2010, 2011/2012) documentaron un aumento en el porcentaje de sitios positivos para nutria, y un aumento en el rango ocupado por las nutrias en la cuenca del Río Hron, cuando se los compara con 1995/1996. El aumento fue más pronunciado en la parte central de la cuenca y probablemente estuvo relacionado con la mejora de la calidad del agua superficial en las décadas de 1980s y 1990s.

**ARTICLE**

# A NON-INVASIVE GENETIC SURVEY OF OTTERS (*Lutra lutra*) IN AN URBAN ENVIRONMENT: A PILOT STUDY WITH CITIZEN SCIENTISTS

Shane WHITE[1*], David O'NEILL[2], Denise B. O'MEARA[2], Carolyn SHORES[3], Catherine O'REILLY[2] Andrew P. HARRINGTON[4], Gill WEYMAN[5], D. P. SLEEMAN[1]

[1] *School of Biological, Earth and Environmental Sciences, University College Cork, Distillery Fields, North Mall, Cork, Ireland. e-mail: swhite.ucc@gmail.com*
[2]*Mammals in a Sustainable Environment (MISE) Project, Waterford Institute of Technology, Cork Road, Waterford, Ireland*
[3]*Department of Biology, University of Washington, Seattle, 98195-1800, WA, USA*
[4]*Mammals In a Sustainable Environment (MISE) Project, Waterford County Council, Waterford, Ireland*
[5]*Irish Wildlife Trust (IWT), Clogher, Dunmanway, Cork, Ireland.*

(Received 19th April 2013, accepted 25th July 2013)

**Abstract:** Acquiring reliable estimates for an elusive species' distribution and population size can be problematic. For cryptic species such as the Eurasian otter (*Lutra lutra*), traditional monitoring approaches rely heavily on identifying field signs that may under or overestimate population sizes. Increasingly, non-invasive genetic sampling is effectively applied to assess the abundance and population structure of otters by genotyping faeces (spraints). Here we present the results of a non-invasive survey conducted in Cork City, Ireland, which aimed to estimate otter population size, sex ratio and genetic diversity. We incorporated a citizen science approach by training members of the public in spraint collection, thus increasing our search effort and sample detection rate. From October 2011 to May 2012, 199 spraints were collected and 187 (94%) were genetically identified as otter. Of these positive otter samples, 13 spraints (7%) yielded genetic information identifying 11 individuals (5 female and 6 male) using nine microsatellite loci. The results indicate that the urban environment does not prevent otters from using the area and we consider the implications based upon contemporary knowledge on otter spatial behaviour. This study demonstrates that non-invasive survey techniques combined with a citizen science approach can effectively reveal otter population parameters and increase urban otter awareness within the community.

Keywords: Urban ecology, population size, non-invasive genetic sampling, sex ratio, faecal DNA, Ireland

## INTRODUCTION

The world is becoming increasingly urbanised, and wildlife are adapting to this frequently, albeit with some difficulties (McKinney, 2002). Numerous carnivore species have demonstrated a capability to adapt to urbanisation, such as red foxes (*Vulpes vulpes)* and stone martens (*Martes foina*) which are now common in many European cities (Gloor et al., 2001; Ní Lamhna, 2008; Herr et al., 2009). In North America, coyotes (*Canis latrans*) and raccoons (*Procyon lotor*) also occur in highly urbanised areas (Ordeñana et al., 2010). Sleeman and Moore (2005) and Park et al. (2011) suggest otters may also be a familiar, though rarely observed, urban species. Throughout Europe, otter populations declined in the last century due to habitat loss, persecution and bio-accumulative pollutants in the food chain (Ruiz-Olmo et al., 2008). However, in the past few decades otter populations have recovered across much of their range (Conroy and Chanin, 2000; Mason and Macdonald, 2004) and otters today are still common throughout Ireland (Marnell et al., 2011; Reid, 2012), including in urban areas (Chapman and Chapman, 1982; Scott, 2004; Sleeman and Moore, 2005; Ní Lamhna, 2008).

Although otters are a widespread and well-studied species (Ruiz-Olmo et al., 2008), knowledge regarding fundamental aspects of their resource selection and population dynamics are still limited (Kruuk, 2006). This is especially true in urban areas that are often assumed to be barriers or poor otter habitat (Lundy and Montgomery, 2010; Hobbs et al., 2011; Park et al., 2011). This lack of information suggests a need for improved survey techniques to better understand otter populations. Non-invasive genetic sampling (NGS), which entails the extraction of DNA from hair, scat and other sources (Taberlet et al., 1999; Broquet et al., 2007), is a key element to improve surveys (Kelly et al., 2012) and has proven to be an effective method for monitoring cryptic and rare species (Palomares et al., 2002; Bellemain et al., 2005). NGS has previously been effective for otters (Park et al. 2011, Hájková et al., 2009). Analysis of DNA from otter spraints (faeces) can provide information on this species distribution, abundance, sex ratio and genetic diversity (Park et al., 2011). Regular wildlife sampling methods such as direct sightings and radio telemetry are not always appropriate for otters (Kruuk, 2006), therefore these indirect NGS methods offer a more reliable approach (Arrendal et al., 2007; Hájková et al., 2009; Park et al., 2011). Constraints with NGS do exist however, specifically with the quantity and quality of DNA extracted from spraints (Hájková et al., 2006; Bonesi et al., 2012).

NGS can be further complemented by the incorporation of citizen science. This approach involves the use of volunteers that are trained to participate in the collection of data for scientific studies. Citizen science has proven to be a valuable tool in providing information for research (Silverton, 2009). For instance, the OPAL (Open Air Laboratories) project in Britain has encouraged the public to participate in environmental surveys throughout the country generating large amounts of data (http://www.opalexplorenature.org, Tweddle et al., 2012). The National Biodiversity Data Centre in Ireland also encourages online submissions by citizen scientists to record mammal sightings to help build the "Atlas of Irish Mammals" (http://mammals.biodiversityireland.ie/). This approach to wildlife monitoring has also proven effective for otter research. For example, Black (2009) built a network of sightings of the river otter (*Lontra canadensis*) in North America involving citizen scientists, as have researchers (Okes, 2013) in South Africa's Cape Peninsula studying urban Cape clawless otters *(Aonyx capensis*) and Park et al. (2011) recorded the collection of Eurasian otter spraints in Daegu City, Korea for a TV show, a process that engaged viewers in the survey method. One of the first studies in Britain that relied on volunteers for the collection of spraints for genetic analysis was conducted by Coxon et al. (1999). Similarly Cardiff University's otter project (e.g. Stanton et al., 2009) avails of social networking and the use of volunteers.

In this study, NGS complemented with citizen science was used to survey a population of urban otters in Cork City. Sprints were collected by trained volunteers to reveal otter presence, numbers, and genetic diversity. Our specific aims were to (1) test the efficacy of NGS from spraints collected by citizen scientist volunteers, (2) determine the sex ratio of otters in Cork City, (3) determine the minimum number of individual otters and (4) estimate the genetic diversity of otters present in the city.

## METHODS
### Study area

Cork City in the south of Ireland is located on the edge of Cork Harbour with an urban area incorporating roughly 37 $km^2$. The River Lee, with various channels and tributaries, flows through the city (Fig 1).

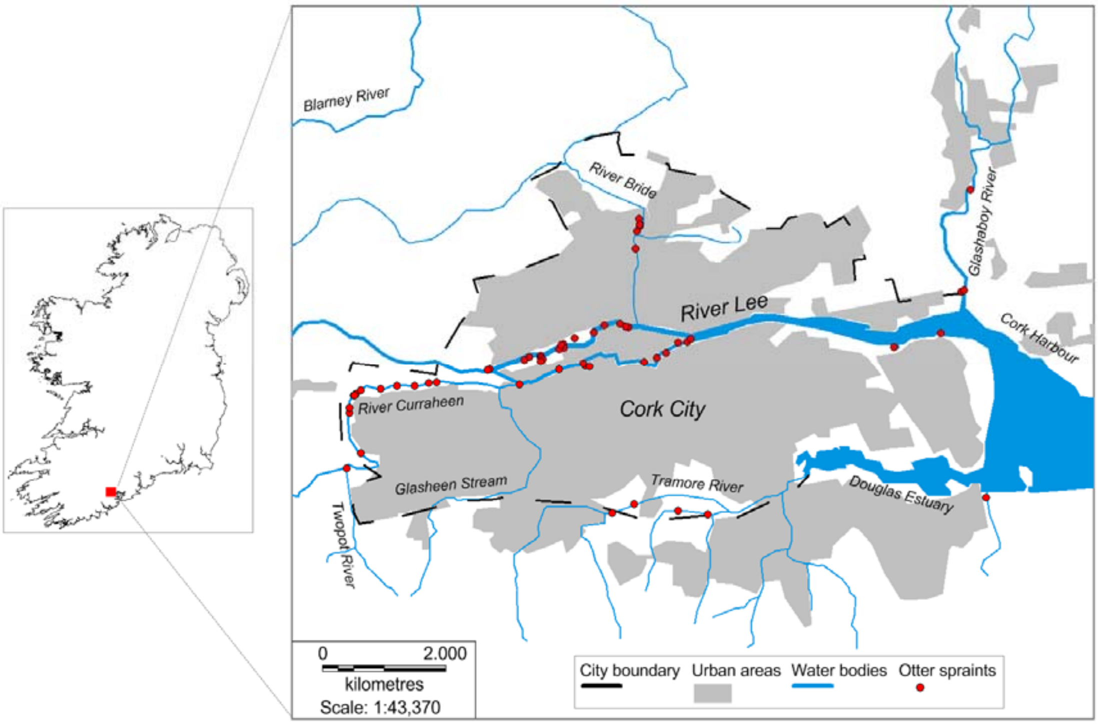



**Figure 1.** Map of the study area and distribution of genetically verified otter spraints collected during the survey.

### Sampling and Analysis

Data for this project was acquired using citizen science monitoring, and volunteers were recruited through the Cork branch of the Irish Wildlife Trust (IWT). Social media was also used to generate public interest. Training events took place before each survey where volunteers were presented with short talks about general otter ecology and guided through standardised otter survey methods (Reuther, 2000).

Spraint collection began in 2011 with 22 trained volunteers and surveying was conducted over 14-21 days across three survey periods (Table 1). The city was divided into five areas that could be comfortably surveyed by teams of 2-4 volunteers. An experienced team leader was assigned to each group who was responsible for submitting the team's spraint collection and documentation to the survey organisers. Surveys were not performed during or immediately after rain when spraints would likely be washed away. River banks were surveyed for otter signs (tracks, holts, resting sites and slides) and spraints were collected in plastic tubes labelled with the location, date and surveyor. Spraints were stored at -20 °C prior to DNA extraction. DNA extraction, molecular species and sex identification of spraints by real-time TaqMan® polymerase chain reaction (PCR) assays and individual identification by microsatellite genotyping (Table 2) were used according to O'Neill et al. (2013). For microsatellite genotyping, primer sets Lut435, Lut833, Lut701, Lut818 (Dallas and

Piertney 1998), Lut457 (Dallas et al., 2002), 04OT05, 04OT14 and 04OT22 (Huang et al., 2005) and 04OT17mini-r (O'Neill et al., 2013) were used. Samples were assayed in duplicate, independent PCRs and only those with allele replicates at a minimum of eight of the nine loci were used for data analysis.

**Data analysis**

The software GIMLET, version 1.3.4 (Valière, 2002) was used to assess the replicated data for the presence of errors including the presence of allelic drop out and false alleles. GIMLET was also used to calculate the percentage of positive PCRs in the overall dataset and the final sample set. The software program GENEPOP, version 4.0.10 (Rousset, 2009) was used to assess gametic phase linkage disequilibria by Fisher's method (1000 dememorizations and 5000 iterations) and deviations from Hardy–Weinberg equilibrium (default settings, exact tests). Expected ($H_E$) and observed ($H_O$) heterozygosities, the number of alleles and the probability of identity (*PI*) were calculated using GENALEX (Peakall and Smouse, 2006). Allelic richness ($R_S$) and the allele size range ($a_s$) were assessed using FSTAT, version 2.9.3.2 (Goudet, 2002).

## RESULTS

From October 2011 to May 2012, 199 spraints were collected for DNA analysis throughout the five urban study areas. In 2011 and 2012, 53 and 146 samples were collected, respectively. In total, 187 samples (94%) were genetically identified as otter spraint. Three mink (*Neovison vison*) scats were identified by DNA sequence analysis and the remaining 9 samples could not be identified to species, most likely due to degraded DNA. Of the positively identified otter spraints, 42 were female, 87 were male, 47 were undetermined and 11 were not tested due to insufficient quantities of DNA. All genetically identified otter spraints from Cork City were mapped onto Ordnance Survey Ireland (OSI) maps using MapInfo 11.0 ™ GIS software (Fig.1). Of the positively identified otter spraints, thirteen (7%) were successfully identified to the individual at 9 microsatellite loci, providing 11 unique genotypes (male n=6, female n=5) (Table 1). The probability of identity ($PI = 3.2 \times 10^{-3}$) indicated that a minimum of four loci were needed to identify unique individuals.

A total of 71 samples were genotyped. Across this entire dataset, PCR success averaged 0.47, ranging from 0.24 at Lut818 to 0.64 at Lut435. Allelic Dropout across all loci was 0.059, ranging from 0.019 at Lut701 to 0.2 at Lut701. Two loci remained error free, 04Ot17 and 04Ot22. To ensure that the data was accurate and to avoid errors, especially identifying spurious individuals, we only used samples that amplified at a minimum of 8 loci, and when the data replicated exactly matched. This reduced the final dataset to 13 samples. Within this dataset, PCR success rates ranged from 0.80 at Lut457 and Lut701 to 1.0 at Lut833, 04OT14, 04OT17 and 04OT22, with an overall average of 0.92 across all loci. There was no evidence of allelic dropout or false alleles in the final dataset used to identify individual otters. All otters identified were unique to each study period with the number of otters detected during each survey ranging from 2-5. One male was detected three times on the same day approximately 300 metres apart. No other individuals were recaptured during surveys.

**Table 1.** Numbers and sex of otters identified

| Survey period | No. of Otters | Male | Female | Recapture |
|---|---|---|---|---|
| Oct/Nov 2011 | 4 | 1 | 3 | 0 |
| Jan/Feb 2012 | 2 | 1 | 1 | 0 |
| May 2012 | 5 | 4 | 1 | 2 |
| Total: | **11** | **6** | **5** | **2** |

## Genetic variability

The number of alleles per locus per sample ranged from two at *04OT14* and *04OT17* to four at *Lut435, Lut701* and *Lut833* (Table 2). Low levels of allelic richness were also observed ($R_s$ = 2.0) at *04OT14* and *04OT17*, with the highest level observed at *Lut701* ($R_s$ = 4.0) (Table 2). $H_E$ ranged from 0.236 at *04OT17* to 0.710 at *Lut701* and $H_O$ ranged from 0.091 at *04OT14* to 1.00 at *Lut701* (Table 2). The following loci exhibited significant deviations from Hardy-Weinberg expectations Lut435, Lut701, Lut818, 04OT14 and 04OT22 ($P$ = 0.05), although the sample size used for this analysis was small.

**Table 2.** Summary statistics

| | **Locus** | | | | | | | | | **Mean across loci** |
|---|---|---|---|---|---|---|---|---|---|---|
| | ***Lut 435*** | ***Lut 457*** | ***Lut 701*** | ***Lut 818*** | ***Lut 833*** | ***04 OT05*** | ***04 OT14*** | ***04 OT17*** | ***04 OT22*** | |
| $N$ | 10 | 9 | 9 | 10 | 11 | 10 | 11 | 11 | 11 | 10.2 |
| $a$ | 4 | 3 | 4 | 3 | 4 | 3 | 2 | 2 | 3 | 3.1 |
| $R_s$ | 3.8 | 3.0 | 4.0 | 3.0 | 3.8 | 3.0 | 2.0 | 2.0 | 2.8 | 3.0 |
| $a_s$ | 122-134 | 138-142 | 194-206 | 180-188 | 157-169 | 168-176 | 122-142 | 124-128 | 148-160 | |
| $H_E$ | 0.545 | 0.426 | 0.710 | 0.620 | 0.690 | 0.555 | 0.434 | 0.236 | 0.368 | 0.509 |
| $H_O$ | 0.200 | 0.444 | 1.000 | 0.600 | 0.727 | 0.700 | 0.091 | 0.273 | 0.182 | 0.469 |
| $HW$ | **0.005** | 0.238 | **0.025** | **0.011** | 0.111 | 1.000 | **0.017** | 1.000 | **0.033** | |

N = number of individuals; $a$ = number of alleles, $R_s$ = allelic richness, $a_s$ = allele size range; $H_E$ = Expected heterozygosity; $H_O$ = observed heterozygosity, $HW$ = Probability values of Hardy-Weinberg expectations.

## DISCUSSION

At least 11 otters, five females and six males, used the city during the survey period. Considering the small study area (~37 km$^2$) and current knowledge of otter spatial ecology (Kruuk, 2006; Koelewijn et al., 2010), a relatively high number of otters were found in the city centre. Previous studies relying on the identification of otter tracks speculated that there were between 5-6 otters using Cork City (Sleeman and Moore, 2005). As Cork City is connected to a number of fresh water systems (Fig. 1) and borders a large natural marine harbour, otters may be using Cork City as an important corridor between marine and freshwater habitats to increase resources and foraging opportunities. This may explain why recaptures were low as otters may not reside long term in the area. Our low success rate at identifying individual otters may have also contributed to this. Alternatively, a source-sink dynamic may exist between rural and urban otter habitats and populations (Sulkava et al., 2007). The high number of otters in Cork City, along with similar findings by Park et al. (2011), challenges the assumption that cities are poor habitats for otters. To address these questions, there is a need for a more comprehensive study into the wider otter population of County Cork, applying recommendations for improving spraint collection methods. In addition, dietary studies could be used to establish the food resources available in the local environment.

Although there did not appear to be a sex bias in the genetically identified individuals, 67% of the samples identified to sex were male. Bonesi et al. (2012) described a similar problem on the River Thames where males were more likely to be territorial and spraint more frequently than females, introducing a possible sex bias in the sampling strategy. Since little is known about the sex ratio of the urban population, it is not possible to infer if the results presented in this study are indeed biased due to the small number of genetically identified individuals, or if the result is representative of the true population. A low to moderate level of genetic diversity was observed among otters in Cork City, but the sample size was small. Three loci used in this study are comparable with the urban otter study by Park et al. (2011): *Lut435, Lut457*, *Lut701,* which resulted in similar levels of expected heterozygosity ($H_E$ = ~0.6). Future studies should increase the sampling region outside the city to get a wider estimate of the genetic diversity of the population in the area, as this study has not been able to ascertain if the otters sampled are resident individuals.

Only 7% of spraints yielded genotypes that were adequate to identify individuals, a low success rate compared with published studies (Arrendal et al., 2007; Bonesi et al., 2012; Hájková et al., 2009; Koelewijn et al., 2010; Park et al., 2011). Our findings therefore represent a minimum population size. A number of reasons may have contributed to the low genotyping success rate observed in this study. Many of the spraints collected were old and possibly of low DNA quality. The use of DNA extracted from anal jelly that occurs with spraints can increase the genotyping success rate (Lampa et al., 2008), but this was not frequently encountered by the survey teams. Spraints were sometimes not submitted by volunteers up to one week post survey. DNA in spraints degrades faster when exposed to warm temperatures (Hájková et al., 2006), and as spraints were typically not frozen by volunteers prior to submission, reducing the time between sample collection and freezer storage could improve the success rate. Surveyors could also be encouraged to collect only fresh spraints and to freeze them in their homes. An alternative may be to provide volunteers with 96% ethanol, but the feasibility of using this with volunteers has not been investigated.

Citizen scientists aided this study by increasing the sampling effort and area surveyed. An additional benefit to the wider community by involving volunteers in such research is that it helps to increase their knowledge of urban ecology. During the training events that were held for each survey, volunteers were presented with the results of the previous survey and were kept informed of the study progress. Local schools were also involved through talks and school children were encouraged to name the genetically identified otters. An education resource pack was developed by the IWT to disseminate the findings of this survey to local schools. Citizen science requires a commitment to continually engage with volunteers and ensure that adequate feedback is provided to participants. This can be time consuming and the constraints of such an approach should be considered when developing similar projects. The combination of NGS and citizen science will be valuable in Britain where citizen science is already well established and the otter population seems to be recovering (Hobbs et al., 2011; Harris, 2013).

Despite a small sample size, this study demonstrates the first use of non-invasive genetic survey techniques on urban otter ecology in Ireland and Britain, and provides baseline estimates of the distribution, genetic diversity, sex and number of otters in an urbanized area. The genetic sampling of otter faecal DNA may complement and improve existing traditional protocols and yield more accurate information into their spatial habits, population parameters and behaviours, thus ensuring that their conservation needs are met.

**Acknowledgements -** We wish to thank Fota Wildlife Park, Cork City Council, Clarion Hotel and Port of Cork and all the volunteers who assisted this study, specifically; Dr Simon Harrison, Ger Stanton, Jess Black, Deirdre

Clifford, Helen Creedon, Lee Jane Eastwood, Brendan Fennessey, Marlynne Headworth, Helena Jackson, Eoin Kelleher, Jed Kempf, Aidan Looney, Maeve McCarthy, Sean McKeon, Lynda McSweeny, Charlotte Leeder, Richard Mundy, John Noonan, Mary O'Brien, Tony O'Dwyer, Niamh O'Flynn, David O'Leary, Deirdre O'Leary, Fiona Patterson, Brian Power, Ruth Prendergast, Séan Ronayne, Geraldine Scannel, Valerie Soma, Risteard Tobin, Fionnula Vereker and Ciara White. Special thanks to Katyana Vert-pre and Gorka Ortuzar Ugarte for providing French and Spanish summary translations. The Mammals In a Sustainable Environment (MISE) Project is funded by the European Regional Development Fund under the Ireland Wales Programme 2007-2013 (INTERREG IVA).

## REFERENCES

**Arrendal, J., Vilá, C., Björklund, M. (2007).** Reliability of noninvasive genetic census of otters compared to field censuses. *Conservation Genetics* **8**:1097-1107.

**Black, M.J. (2009).** River otter monitoring by citizen science volunteers in Northern California: social groups and litter size. *Northwestern Naturalist* **90**: 130-135.

**Bellemain, E., Swenson, E.J., Tallmom, A.D., Brunberg, S., Taberlet, P. (2005).** Estimating population size of elusive animals with DNA from hunter-collected feces: four methods for brown bears. *Conservation Biology* **19**(1): 150-161.

**Bonesi, L., Hale, M., MacDonald, W.D. (2012).** Lessons from the use of non-invasive genetic sampling as a way to estimate Eurasian otter population size and sex ratio. *Acta Theriologica*: 1-12.

**Broquet, T., Ménard, N., Petit, E. (2006).** Noninvasive population genetics: a review of sample source, diet, fragment length and microsatellite motif effects on amplification success and genotyping error rates. *Conservation Genetics* **8**: 249-260.

**Chapman, P.J., Chapman, L.L. (1982).** The otter survey of Ireland. Vincent Wildlife Trust, London.

**Conroy, J.W.H., Chanin, P.R.F. (2000)**. The status of the Eurasian otter (*Lutra lutra*) in Europe. A Review. In: **Conroy J.W.H, Yoxon P. and Gutleb A.C.** (eds), Proceedings of the First Otter Toxicology Conference, Journal of the International Otter Survival Fund, 1: 7-28.

**Coxon, K., Chanin, P., Dallas, J., Sykes, T. (1999)**. The use of DNA fingerprinting to study the population dynamics of otters (*Lutra lutra*) in southern Britain: a feasibility study. Environment Agency R&D Project WI-025.

**Dallas, J.F., Piertney, S.B. (1998).** Microsatellite primers for the Eurasian otter. *Molecular Ecology* **7**:1248-1251.

**Dallas, J.F., Marshall, F., Piertney, S.B., Bacon, P.J., Racey, P.A. (2002).** Spatially restricted gene flow and reduced microsatellite polymorphism in the Eurasian otter *Lutra lutra* in Britain. *Conservation Genetics*, **3**,15–29.

**Gloor, S., Bontadina, F., Hegglin, D., Deplazes, P., Breitenmoser, U. (2001).** The rise of urban fox populations in Switzerland. *Mammalian Biology* **6**: 155-164.

**Goudet, J. (2002).** FSTAT, a program to estimate and test gene diversities and fixation indices (version 2.9.3.2). http://www2.unil.ch/ popgen/softwares/fstat.htm.

**Hájková, P., Zemanová, B., Bryja, J., Hájek, B., Roche, K., Tkadlec, E., Zima, J. (2006).** Factors affecting success of PCR amplification of microsatellite loci from otter faeces. *Molecular Ecology Notes* **6**:559–562.

**Hájková, P., Zemanová, B., Roche, K., Hájek, B. (2009).** An evaluation of field and noninvasive genetic methods for estimating Eurasian otter population size. *Conservation Genetics* **10**:1667–1681.

**Harris, S. (2013).** A Green & Pleasant Land? *BBC Wildlife Magazine* January 47-50.

**Herr, J., Schley, L., Roper, T.J. (2009).** Socio-spatial organisation of urban stone martens. *Journal of Zoology* **77**: 54–62.

**Hobbs, G.I., Chadwick, E.A., Bruford, M.W., Slater, F.M. (2011).** Bayesian clustering techniques and progressive partitioning to identify population structuring within a recovering otter population in the UK. *Journal of Applied Ecology* **48**: 1206-1217

**Huang, C.C., Hsu, Y.C., Lee, L.L., Li, S.-H. (2005).** Isolation and characterization of tetramicrosatellite DNA markers in the Eurasian otter (*Lutra lutra*). *Molecular Ecology Notes*, **5**, 314-316.

**Kelly, M. J.,Betsch, J., Wultsh, C., Mesa, B., Mills, L.S. (2012).** Noninvasive sampling for carnivores. In: **Boitani, L., Rowell, R.A**. (eds.) Carnivore Ecology and Conservation, a handbook of techniques. Oxford University Press, Oxford.

**Koelewijn, H.P., Pérez-Haro, M., Jansman, H.A.H., Boerwinkel, M.C., Bovenschen, J., Lammertsma, D. R., Niewold, F.J.J., Kuiters, A.T. (2010).** The reintroduction of the Eurasian otter (*Lutra lutra*) into the Netherlands: hidden life revealed by noninvasive genetic monitoring. *Conservation Genetics* **11**:601–614.

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

**Lampa, S., Gruber, B., Henle, K., Hoehn, M. (2008).** An optimisation approach to increase DNA amplification success of otter faeces. *Conservation Genetics* **9**:201–210.

**Lundy, M.G., Montgomery, W.I. (2010).** A multi-scale analysis of the habit associations of the European otter and American mink and implications for farm scale conservation schemes. *Biodiversity and Conservation* **19**: 3849-3859.

**Marnell, F., O'Neill, L., Lynn, D. (2011).** How to calculate range and population size for the otter? The Irish approach as a case study. IUCN Otter Spec. Group Bull. **28B**: 15-22.

**Mason, C.F., Macdonald, S.M. (2004).** Growth in otter (*Lutra lutra*) populations in the UK as shown by long-term monitoring. *Ambio* **33**: 148–152.

**McKinney, M.L. (2002).** Urbanization, biodiversity, and conservation. *BioScience* **52**: 883–890.

**Ní Lamhna, E. (2008).** Wild Dublin. O'Brien Press.

**Okes, N. (2013).** Spatial ecology and health of Cape Clawless Otter in an urban environment –current research on the Cape Peninsula. Abstract at Wild Mustelid Conference- the biology and conservation of wild mustelids, skunks, procyonids and red pandas. Oxford University 18-21 March 2013.

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

**Ordeñana, A.M., Crooks, R.K., Boydston, E.E., Fisher, N.R., Lyren, M.L., Siudyla, S., Haas, C., Harris, S., Hathaway, A.S., Turschak, M.G., Miles, K.A., van Vuren, H.D. (2010)**. The effects of urbanization on carnivore species distribution and richness. *Journal of Mammalogy* **91**: 1322-1331

**Palomares, F., Godoy, A.J., Pirizs, A., O'Brien, J.S., Johnson, E.W. (2002).** Faecal genetic analysis to determine the presence and distribution of elusive carnivores: Design and feasibility for the Iberian lynx. *Molecular Ecology* **11**:2171-2182.

**Park, H-C., Han, T-Y., Kim, D-C., Min, M-S., Han, S-Y., Kim, K-S., Lee, H. (2011).** Individual identification and sex determination of Eurasian otters (*Lutra lutra*) in Daegu city based on genetic analysis of otter spraint. *Genes & Genomics* **33**: 653-657.

**Peakall, R.O.D., Smouse, P.E. (2006).** genalex 6: genetic analysis in Excel. Population genetic software for teaching and research. *Molecular Ecology Notes* **6**: 288-295.

**Reid, N. (2012).** Detecting detectability: quantifying uncertainty of otter incidence. Abstract at All Ireland Mammal Symposium, Invasive Species Ireland, Dublin.

**Reuther, C. (2000).** Surveying and monitoring distribution and population trends of the European otter (*Lutra lutra*): guidelines and evaluation of the standard methods for surveys as recommended by the European section of the IUCN/SSC otter specialist group. Hankensbüttel, Gruppe Naturschutz.

**Rousset, F. (2009).** Genepop'007: a complete re-implementation of the Genepop software for Windows and Linux. *Molecular Ecology Research* **8**: 103–106.

**Ruiz-Olmo, J., Loy, A., Cianfrani, C., Yoxon, P., Yoxon, G., de Silva, P. K., Roos, A., Bisther, M., Hájková, P., Zemanova, B. (2008).** *Lutra lutra*. IUCN red list of threatened species. Version 2012.1. Available from www.iucnlist.org

**Scott, R. (2004).** Wild Belfast, on safari in the city. Blackstaff Press, Belfast.

**Silvertown, J. (2009).** A new dawn for citizen science. *Trends in Ecology & Evolution* **24**: 467-71.

**Sleeman, D.P., Moore, P. (2005).** Otters *Lutra lutra* in Cork City. *Irish Naturalists' Journal* **28**: 73-79.

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

**Sulkava, R.T., Sulkava, P., Sulkava, P.E. (2007).** Source and sink dynamics of density dependant otter (*Lutra lutra*) populations in rivers of central Finland. *Oecologia* **153**: 579-588.

**Taberlet P, Waits LP, Luikart G (1999).** Noninvasive genetic sampling: look before you leap. *Trends in Ecology and Evolution*, **14** (8), 323 – 327.

**Tweddle, J.C., Robinson, L.D., Pocock, M.J.O., Roy, H.E (2012).** Guide to citizen science: developing, implementing and evaluating citizen science to study biodiversity and the environment in the UK. Natural History Museum and NERC Centre for Ecology & Hydrology for UK-EOF. Available online: www.ukeof.org.uk

**Valière, N. (2002).** GIMLET: a computer program for analysing genetic individual identification data. *Molecular Ecology Notes* **2**: 377–379.

**RÉSUMÉ**

**ETUDE GÉNÉTIQUE NON INVASIVE DES LOUTRES (*Lutra lutra*) DANS UN ENVIRONNEMENT URBAIN: PROGRAMME PILOTE AVEC DES CITOYENS SCIETIFIQUES.**

Obtenir des données fiables afin d'estimer la distribution et la taille de population d'une espèce à faible probabilité de détection peut être problématique. Pour des espèces cryptiques telles que la loutre Eurasienne (*Lutra lutra*), les approches traditionnelles de suivi reposent majoritairement sur l'identification de signes présents sur le terrain, et pouvant entrainer la sous ou surestimation de la taille de population. De plus en plus souvent, une méthode d'échantillonnage génétique non invasive est utilisée efficacement afin d'évaluer l'abondance et la structure de population des loutres en génotypant les fèces (épreintes). Dans cette étude, on présente les résultats d'un suivi non invasif réalisé à Cork City (Irlande), dont le but est d'estimer la taille de population, le sexe ratio ainsi que la diversité génétique de la loutre. Le suivi intègre une approche scientifique civile qui consiste à entrainer les membres du public à collecter les épreintes, permettant d'augmenter l'effort de recherche et le taux de détection d'un échantillon. D'Octobre 2011 à Mai 2012, 199 épreintes ont été collectées et 187 (94%) ont été génétiquement identifiées comme loutre. Parmi ces échantillons positifs de loutres, 13 épreintes (7%) ont révélées, en utilisant neuf loci microsatellites, l'information génétique de 11 individus (5 femelles et 6 males). Les résultats indiquent que l'environnement urbain ne restreint pas les loutres pour l'utilisation de la zone, aussi, on considère les implications basées sur les connaissances contemporaines du comportement spatial de loutre. Cette étude révèle que la combinaison des techniques de suivi non invasives et de l'approche scientifique civile peut de façon efficace révéler les paramètres de population de loutre et augmenter la conscience collective urbaine en ce qui concerne les loutres.

**RESUMEN**

**ANÁLISIS GENÉTICO NO INVASIVO DE NUTRIAS (*Lutra lutra*) EN UN MEDIO URBANO: ESTUDIO PILOTO USANDO CIENCIA CIUDADANA.**

La adquisición de estimaciones fiables sobre la distribución y el tamaño poblacional de una especie esquiva puede acarrear ciertos problemas. En el caso de especies crípticas como la nutria europea o paleártica (Lutra lutra), el monitoreo tradicional se basa en la robusta confianza en la identificación de restos en la zona de estudio, lo que puede generar una infra o sobre-estimación del tamaño de la población. Además, muestreos genéticos no invasivos como la genotipificación de heces, están siendo aplicados, positivamente, para la evaluación de la abundancia y la estructura de la población de nutria. En el presente articulo se facilitan los resultados de un muestreo no invasivo llevado a cabo en la ciudad de Cork, Irlanda, que tenía por objetivo la estimación del tamaño de la población, la proporción de sexos y la diversidad genética. La incorporación de un enfoque científico-ciudadano mediante el entrenamiento de personas del público general para la recogida de excrementos, incrementó el esfuerzo de muestreo y el rango de detección de muestras. Desde octubre del 2011 hasta mayo de 2012 fueron recogidas 199 muestras de excrementos donde 187 (94%) fueron identificadas genéticamente como de nutria. Del conjunto de estas últimas, 13 de ellas (7%) dieron una información genética, que mediante la localización de 9 microsatélites, permitieron identificar 11 individuos (5 hembras y 6 machos). Los resultados indican que el medio urbano no previene a las nutrias en el uso del espacio y consideramos las implicaciones sobre la base del conocimiento contemporáneo en el comportamiento espacial de la nutria. Este estudio demuestra que las técnicas de estudio no invasivo combinadas con un enfoque de ciencia ciudadana pueden revelar con eficacia los parámetros de población de nutria y aumentar la conciencia de los urbanitas acerca de la nutria dentro de la comunidad.

**SHORT NOTE**

# NEW RECORDS OF HAIRY-NOSED OTTER (*Lutra sumatrana)* IN PENINSULAR MALAYSIA

Nick BAKER

*Nature enthusiast and photographer,*
*Webmaster of amateur website EcologyAsia; nick-baker@ecologyasia.com*

(submitted 20th September 2013, accepted 20th October 2013)

**Abstract:** Two sightings of Hairy-nosed Otter (*Lutra sumatrana*) were made at Sungai Tanum and Sungai Relau, Taman Negara, Pahang, Peninsular Malaysia. These are the third and fourth formally documented records of the species from Peninsular Malaysia since the 1960's, and the first records from Taman Negara in the same period.

**Keywords:** Taman Negara; Pahang; Sungai Tanum; Sungai Relau; *Lutra sumatrana*

## INTRODUCTION

The Hairy-nosed Otter *Lutra sumatrana*, is a rarely seen animal throughout its range in Southeast Asia. In Peninsular Malaysia, Sebastian (1995) discusses two records of *L. sumatrana*, both roadkills in areas close to peat swamp forest, one in 1991 in the state of Perak and another in 1994 in the state of Pahang. Sebastian (1995) also states that "*L. sumatrana* had not been recorded in the peninsula since the sixties".

Between May 2013 and September 2013 the author made two trips to the western entrance of the protected area of Taman Negara, Peninsular Malaysia, just east of the town of Merapoh. The habitat comprises intact, lowland dipterocarp forest. One otter was seen and photographed on each trip, on 15th May and 10th September. Subsequent review of images from both sightings shows the species to be the Hairy-nosed Otter *Lutra sumatrana*. Although the diagnostic hairy rhinarium cannot be clearly seen, the pale lips, chin and neck are evident in the photographs. In addition the fur appears somewhat rough, and the head somewhat flattened.

## DETAILS OF SIGHTINGS

### 15th May 2013

On 15th May 2013 the author visited Sungai Tanum (Kuala Juram) (Lat 4 38.751 Long 102 07.941) with two other nature photographers. Kuala Juram is accessible from the western entrance of Taman Negara, just east of Merapoh. The main gate to Taman Negara is 6 km east of Merapoh, and Kuala Juram a further 9.5 km east. Kuala Juram lies at the confluence of two rivers, the smaller Sungai Juram and larger Sungai Tanum. (In Malay, Kuala = Confluence, Sungai = River). See map (Figure 1). The elevation of Kuala Juram is around 190 metres above sea level, based on a GPS fix.

Taman Negara (In Malay, Taman = Park, Negara = Country i.e. National Park) was established in 1938, and is the largest protected area in Peninsular Malaysia. It lies mainly within the state of Pahang and covers more than 4,000 square kilometres.

At 07:58 the author arrived at Sungai Tanum, and set up his camera gear on a rocky sandbank at the edge of the river, and waited for wildlife to appear. The camera equipment comprised a tripod-mounted Nikon D600 DSLR with a 300mm f2.8 lens.

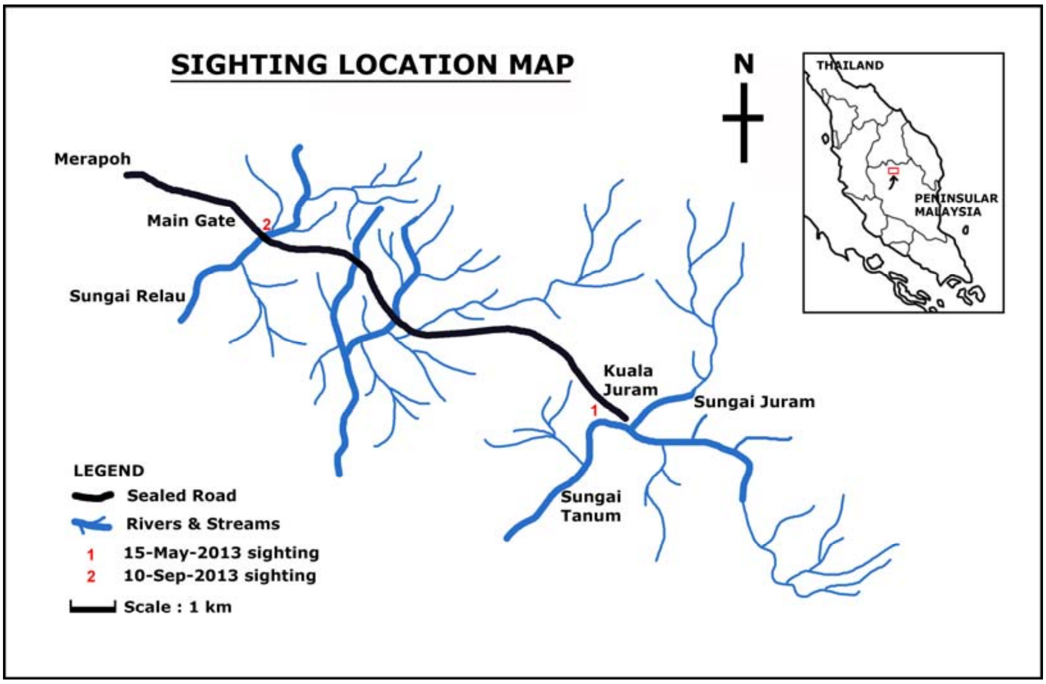



**Figure 1.** Sighting location map

At 09:28 an otter was observed, already fully emerged from the river, quietly exploring the opposite bank of Sungai Tanum: it climbed a few metres up the steeply-sloping river bank, partly hidden by vegetation, and inspected some cavities beneath large tree roots. The otter then slipped back into the water.

At 09:29 the otter reappeared on the same side of Sungai Tanum as the author, about 25 metres downstream: it briefly emerged from beneath some floating debris (tree branches, small tree trunks) which had accumulated at the edge of the river.

At 09:30 the otter appeared for a third time beneath a large fallen tree around 50 metres downstream from the author: its head and neck were out of the water and it was closely inspecting the river bank beneath the fallen tree (Fig 2). Seconds later the otter swam beneath the water. The author waited for another 30 minutes but the otter did not reappear.

River conditions on that morning appeared 'normal': the water was relatively clear, and sandbanks and gravel banks were visible. A storm the previous night had not caused water levels to rise significantly. Weather conditions were cool but dry.

**Figure 2**. *L. sumatrana* at Sungai Tanum inspecting area beneath fallen tree.

## 10th September 2013

On 10th September 2013 another trip was made to Taman Negara with two more nature photographers. At 17:30 a lone Hairy-nosed Otter was briefly observed exploring the eastern bank of Sungai Relau (Lat 4 40.751 Long 102 03.475). The elevation of Sungai Relau is around 170 metres above sea level, based on a GPS fix.

The otter was moving rapidly downstream, but briefly emerged onto a fallen tree trunk where photographs were taken (Fig. 3, 4). The otter was facing towards and inspecting the opposite river bank. The water level in Sungai Relau that afternoon was higher than normal, after recent heavy rain. Some silty discolouration of the water was evident due to runoff from nearby oil palm plantations. Weather conditions were hot and humid.

## DISCUSSION

The author believes that the records of *L. sumatrana* described here are the first and second formally recorded for Peninsular Malaysia since the roadkill record in 1994, and are thus the third and fourth records since the 1960's. These sightings also appear to be the first formal record of the species since at least the 1960's in the protected area of Taman Negara. The habitat at Sungai Tanum (Fig. 5, 6) and Sungai Relau (Fig 7) comprises intact, lowland dipterocarp forest typical of Taman Negara.

The occurrence of *L. sumatrana* in such habitat is significant, as the two previous records were from peat swamp forest.

Sungai Tanum is reasonably free of human disturbance. There is a sealed road leading to the river from the main gate, and some buildings at Kuala Juram itself. The general public do not seem to visit this area much, and boating activities appear to be limited to some ‘outward-bound’ canoeing. Sungai Relau receives rather more disturbance, located as it is at the park entrance, however boating activities appear to be limited and human activity is mainly nature appreciation with some swimming activity.

**Figure 3.** Rear view of *L. sumatrana* at Sungai Relau.

**Figure 4.** Partly obscured view of *L. sumatrana* at Sungai Relau showing white upper and lower lips.

**Figure 5.** Sungai Tanum, view of habitat upstream from sighting location.

**Figure 6.** Sungai Tanum, view of habitat downstream from sighting location.

It should be noted that Sungai Tanum and Sungai Relau both support a sanctuary (i.e. a release area) for captive-raised *Tor tambroides* or 'Mahseer': this fish species is locally known as *Kelah*. For many years recreational fishing was allowed within Taman Negara, to the detriment of fish stocks: this was banned some years ago and a reintroduction program was started for *Kelah*, which is still ongoing. Although the large numbers of fish in the area may have attracted the otters, no interactions between the otters and *Kelah* were observed.

**Figure 7.** Sungai Relau, view of habitat upstream from sighting location.

These two sightings are 9 km apart but are in separate parts of the river system, and are separated by two divides. The confluence of Sungai Tanum and Sungai Relau lies around 11 km south of Merapoh, thus the 'along-river' distance between the two sightings is at least 20 km via the confluence, probably more when the twists and turns of these two rivers are accounted for. It seems therefore likely that two separate otters were seen.

**Acknowledgments -** Thanks to Kelvin Lim, Raffles Museum of Biodiversity Research, Department of Biological Sciences, National University of Singapore for his comments on the manuscript. Thanks to Daniella Zappi, Sylvain Richer de Forges and Nur Fadzleen Niza Mohd Arrifin for translations. Thanks to my travelling companions Graeme Guy, Jeevi Gopal and Horst Flotow.

## REFERENCES

**Sebastian, A. 1995.** The hairy-nosed otter in Peninsular Malaysia. *IUCN Otter Spec. Group Bull.* **11**, 3.

## RÉSUMÉ
## NOUVELLES OBSERVATIONS DE «LOUTRE DE SUMATRA» (*Lutra sumatrana)* EN MALAISIE PENINSULAIRE

Deux observations de "Loutre de Sumatra" (*Lutra sumatrana)* ont été reportées à Sungai Tanum, Sungai Relau, Taman Negara, Pahang en Malaisie Péninsulaire. Ce ne sont que les troisième et quatrième observations officiellement documentées pour ces espèces en Malaisie péninsulaire et cela depuis 1960. Ce sont également les premières observations qui ont été reportées dans la région de Taman Negara depuis cette époque.

## RESUMEN
## REGISTROS DE NUTRIA DE RIO DE NARIZ PELUDA (*Lutra Sumatrana*) EN LA PENINSULA MALASIA

Se cita la observacion de dos especimenes de Nutria de Río de Nariz Peluda (*Lutra sumatrana*) en Sungai Tanum y Sungai Rengau, Taman Negara, Pahang, Península Malasia. Tratanse del tercer y cuarto registros formales de esta especie en Península Malasia desde la década de 1960, y el primer para Taman Negara en ese mismo periodo.

## RINGKASAN
## REKOD BARU MEMERANG KUMIS (*Lutra sumatrana)* DI SEMENANJUNG MALAYSIA

Dua penampakan Memerang Kumis *(Lutra sumatrana)* dibuat di Sungai Tanum dan Sungai Relau, Taman Negara, Pahang, di Semenanjung Malaysia. Ini adalah kali ketiga dan keempat rekod penampakan spesies ini didokumentasikan secara rasmi dari Semenanjung Malaysia sejak tahun 1960-an. Ia juga rekod pertama dari Taman Negara dalam tempoh yang sama.

SHORT NOTE

# NEW OBSERVATION OF THE HAIRY-NOSED OTTER (*Lutra sumatrana*) IN SUMATRA

Kurnia LATIFIANA[1, 2] and Rob S. A. PICKLES[3, 4]

[1]Tambling Wildlife Nature Conservation, Pengekahan, Way Haru Village, Bengkunat Belimbing Subdistrict, West Lampung, Lampung Province, Indonesia
[2]Forest Resources Conservation, Faculty of Forestry, Universitas Gadjah Mada, Jalan Agro No.1 Bulaksumur Yogyakarta, 55281, Indonesia
[3]Department of Biology, Trent University, Peterborough, ON, Canada, K9J 7B8
[4]Panthera, West 40th Street, 18 Floor, New York, NY 10018, USA

**ABSTRACT:** An adult hairy-nosed otter (*Lutra* sumatrana) was photographed by the authors in Tambling Wildlife Nature Conservation, a privately managed concession within the Bukit Barisan Selatan National Park in southern Sumatra. This observation represents the southern-most record of the *L. sumatrana*'s known range and is only the second time in the last fifty years that the species has been recorded in Sumatra.

**Keywords**: *Lutra sumatrana*, Sumatra, Tambling

The hairy-nosed otter (*Lutra sumatrana*) is the world's rarest otter species and its cryptic habits coupled with the difficulty of reliable identifications in the field mean that we lack a good understanding of where the species occurs. The historical distribution stretches from northern Myanmar, South Thailand, Cambodia, South Vietnam, Peninsular Malaysia, Sumatra and Borneo (Figure 1) (Duckworth and Hills 2008; Wright et al., 2008; IUCN 2013). Evidence of the species' continued occurrence in the Malay Archipelago come from recent camera trap footage in Sabah, northern Borneo (Wilting et al., 2010), while the only record of the species in Sumatra in the last fifty years was a road-kill from Sekayu, Palembang, South Sumatera Province (Lubis 2005). The new record is from the southern tip of the Bukit Barisan Selatan National Park, Lampung Province (S 50 51' 38.1" E 140 33' 37.0") (Figure 1). This is 350km south of the 2005 observation and the southern-most record of the species

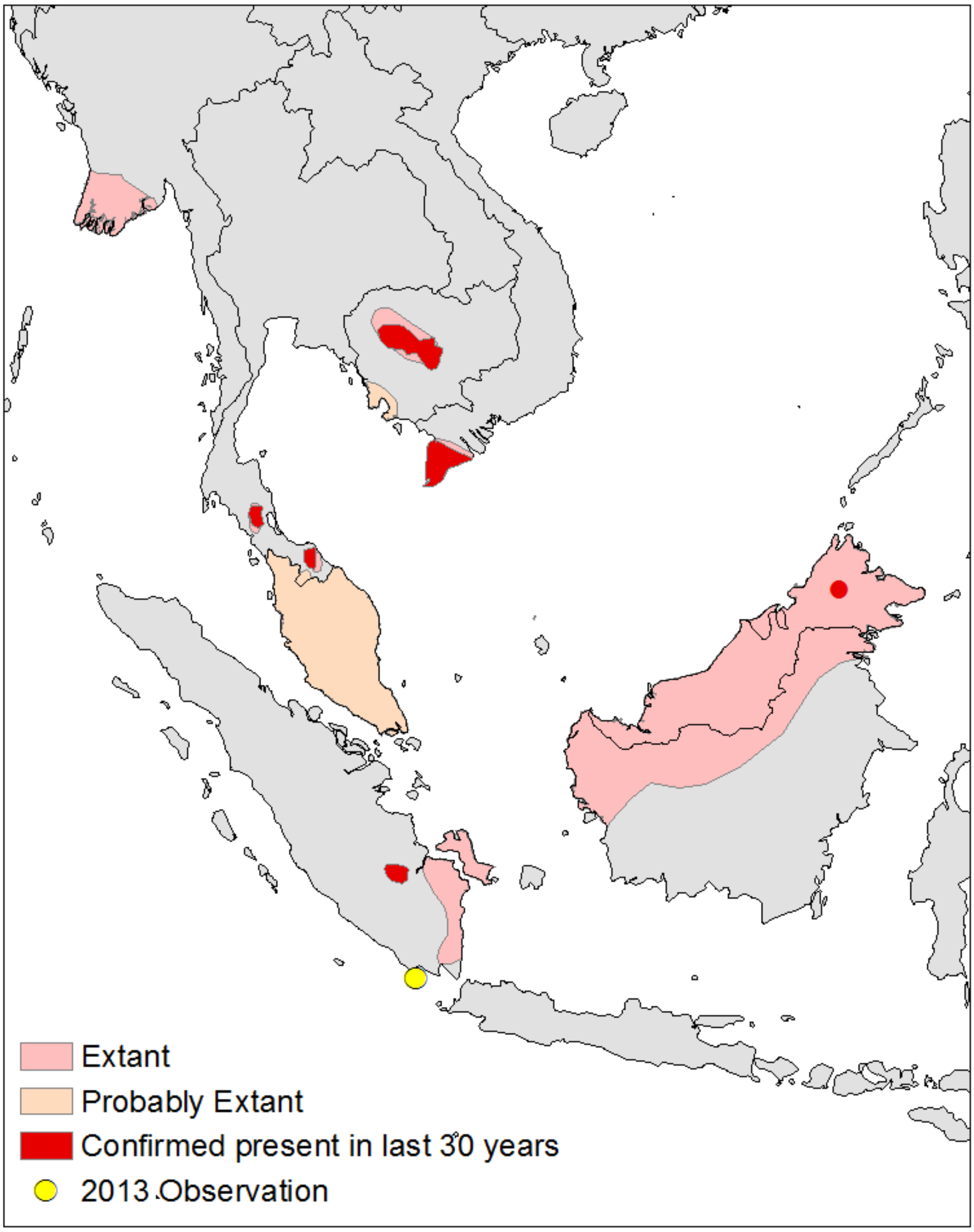



**Figure 1.** The location of this observation (yellow dot) in *L. sumatrana*'s range. The extant and probable extant range delineations are from the IUCN red list (IUCN 2013)

The observation was made at 10.02 am, 10th March 2013 at an estuary mouth on the west coast of Tambling. The otter was first seen at a distance of 50m from the observers, approximately 20m from the high tide line, the animal remaining unaware of our presence as we approached to within 25m. The total duration of the observation was probably no more than five minutes. The otter scent marked a log and groomed itself on the sand before swimming across the river and heading into the swamp. We identified the species from photographs taken at the time based on its large slanted nostrils, furry rhinarium and stark white patches on its lower lip (Figure 2).

**Figure 2**. *Lutra sumatrana* in the Cukuh Babui estuary, Tambling Wildlife Nature Conservation, Bukit Barisan Selatan NP. The otter's characteristic hairy rhinarium and striking white patches on lower lip seen here clearly distinguish the animal from *Lutra lutra*.

The firm sand did not yield good prints, but one impression of a forepaw had a width of 57mm and a length of 59mm (Figure 3). Only four toes were visible. The largest toe had a width of 10mm and the pad with was 21mm. In the fairly symmetrical print the claws were distinct but the interdigital webbing was not visible. Kanchanasaka (2001) reported average forepaw track widths of 58mm from a sample of 23 observations.

**Figure 3.** Forefoot print made by *L. sumatrana* during the observation.

The habitat around the estuary is flooded swamp dominated by nypa palm (*Nypa fruticans*) and mangroves (*Bruguiera* sp., *Avicennia* sp.) with banyans (*Ficus microcarpa*) palms (*Pandanus tectorius*) and baringtonia (*Baringtonia asiatica*) also present, consistent with previous observations of *L. sumatrana*, which have mostly been made in swamps and flooded lowland forest (Wright et al., 2008) (Figure 4).

**Figure 4.** The habitat where the otter was observed (above): the estuary mouth closed by a sand bank and (below) the mangrove swamp further upriver.

In southern Thailand and Vietnam the species has been found in peat swamp forest, with cores of Melaleuca (*Melaleuca cajuputi*) (Kanchanasaka, 2001; Nguyen et al., 2001). The only other recent record of *L. sumatrana* in Sumatra was in an area of flooded open swamp and palm oil plantation (Lubis, 2005). In March the dry season begins in southwestern Sumatra and as the flow rate of the rivers reduces, leading to the mouths of many of the small rivers flowing into the sea become backed up by sand banks, creating a series of temporary lagoons. The Cukuh Babui lagoon appears to offer good hunting potential for prey of *L. sumatrana* with dog-faced water snake (*Cerberus rynchops*) and mangrove cat snake (*Boiga dendrophylla*) common. Water snakes have been reported to represent as much as 18% of the diet of *L. sumatrana* (Kanchanasaka, 2001).

Tambling could represent an important site for the conservation for *L. sumatrana* in Sumatra due to the park's extensive nypa dominated swamps and lagoons along its west and southern coast coupled with the effective control of human encroachment and hunting.

**Acknowledgements -** We are grateful for the generous support of Tambling Wildlife Nature Conservation and Mr Tomy Winata personally. We are also grateful for the support of the Ministry of Forestry of the Republic of Indonesia. We are thankful to Nicole Duplaix and Emmeliana Bujak for confirmation of the species identification.

## REFERENCES

**Duckworth, J.W., Hills, D.M. (2008).** A Specimen of Hairy-Nosed Otter *Lutra sumatrana* from Far Northern Myanmar. *IUCN Otter Specialist Group Bulletin* **25:** 60-67.

**Francis, C.M. (2008).** *A field Guide to the Mammals of South East Asia*. New Holland Publishers, Singapore.

**IUCN (2013).** 2013 IUCN Red List of Threatened Species. Version 2013.1. [Available from www.iucnredlist.org. Downloaded on 3 April 2013.]

**Kanchanasaka, B. (2001).** Tracks and Other Signs of the Hairy-Nosed Otter (*Lutra sumatrana*). *IUCN Otter Specialist Group Bulletin* **18**: 57-63.

**Lubis, R. (2005).** First Recent Record of Hairy-Nosed Otter in Sumatra, Indonesia. *IUCN Otter Specialist Group Bulletin* **18**: 14-20.

**Medway, L. (1969).** *The wild mammals of Malaya and offshore islands including Singapore*. Oxford University Press, London, UK and Oxford, UK

**Nguyen, X.D., Pham, T.A., Le, H.T. (2001).** New Information about the Hairy-Nosed Otter (*Lutra sumatrana*) in Vietnam. *IUCN Otter Specialist Group Bulletin* **18:** 64-75.

**Payne, J., Francis, C.M. (2007).** *A field guide to the mammals of Borneo*. The Sabah Society, Kota Kinabalu.

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

**Wright, L.C., Olsson, A., Kanchanasaka, B. (2008).** A Working Review of the Hairy-Nosed Otter (*Lutra sumatrana*). *IUCN Otter Specialist Group Bulletin* **25:** 38- 59.

**RESUMÉ**

**NOUVELLE OBSERVATION DE LA LOUTRE DE SUMATRA (*Lutra sumatrana*) A SUMATRA**

Une loutre de Sumatra adulte a été photographiée par les auteurs dans la réserve de Tambling, une concession privée dans le parc national de Bukit Barisan Selatan dans le sud de Sumatra. Cette observation représente l'observation la plus au sud de l'aire de répartition connue de *Lutra sumatrana* et seulement la deuxième observation des 50 dernières années de cette espèce à Sumatra.

**RESUMEN**

**NUEVA OBSERVACIÓN DE LA NUTRIA SUMATRANA ( *Lutra sumatrana*) EN SUMATRA**

Una nutria sumatrana ( *Lutra sumatrana*) adulta fue fotografiada por los autores en Tambling Wildlife Nature Conservation, una concesión manejada en forma privada, dentro del Parque Nacional Bukit Barisan Selatan, en el sur de Sumatra. Esta observación representa el registro más meridional de la distribución conocida de *L. sumatrana*, y es la segunda vez en los últimos cicuenta años que se registra la especie en Sumatra.

**RINGKASAN**

**PENGAMATAN BARU BERANG-BERANG HIDUNG BERBULU (*Lutra sumatrana*) DI SUMATERA**

Seekor berang-berang hidung berbulu (*Lutra sumatrana*) terfoto oleh penulis di Tambling Wildlife Nature Conservation, sebuah konsesi yang dikelola oleh swasta di dalam Taman Nasional Bukit Barisan di selatan Sumatera. Pengamatan ini merupakan catatan sebaran paling selatan dari *L. sumatrana* dan merupakan catatan penemuan kedua kalinya jenis ini selama lima puluh tahun terakhir yang tercatat di Sumatra.

# OSG MEMBER NEWS

**James Williams MBE**

James Williams was awarded an MBE in the Queen's birthday honours on 16th June 2013, for conservation of Otters in Somerset. Read more....

The OSG also congratulates James for the well-deserved recognition of his work.

**OSG Annual Report to IUCN/SSC**

We submitted our Annual Report on the state of otters worldwide to the IUCN Species Survival Commission during November 2013

http://www.otterspecialistgroup.org/Library/OSG_Annual_Report_2013.pdf

**New Members of OSG**

Since the last issue, we have welcomed 6 new members to the OSG: you can read more about them on the Members-Only pages.

**Nesime Askin, Canada:** I am interested in advancing otter research and education in Canada and will develop new teaching materials to promote otter ecology and environmental issues. Both as a scientist and as an artist, I hope to fulfill these goals and promote otter ecological and environmental issues to a new generation of academics.

**Victor Camp, USA:** As an independent researcher I am investigating the presence, habitat utilization, and behavioral activities of the North American river otter (*Lontra canadensis*) in gated communities and golf courses in western Lee and Collier counties of southwest Florida. This research is intended to define the extent these man-made environments contribute to the population of river otters in southwest Florida.

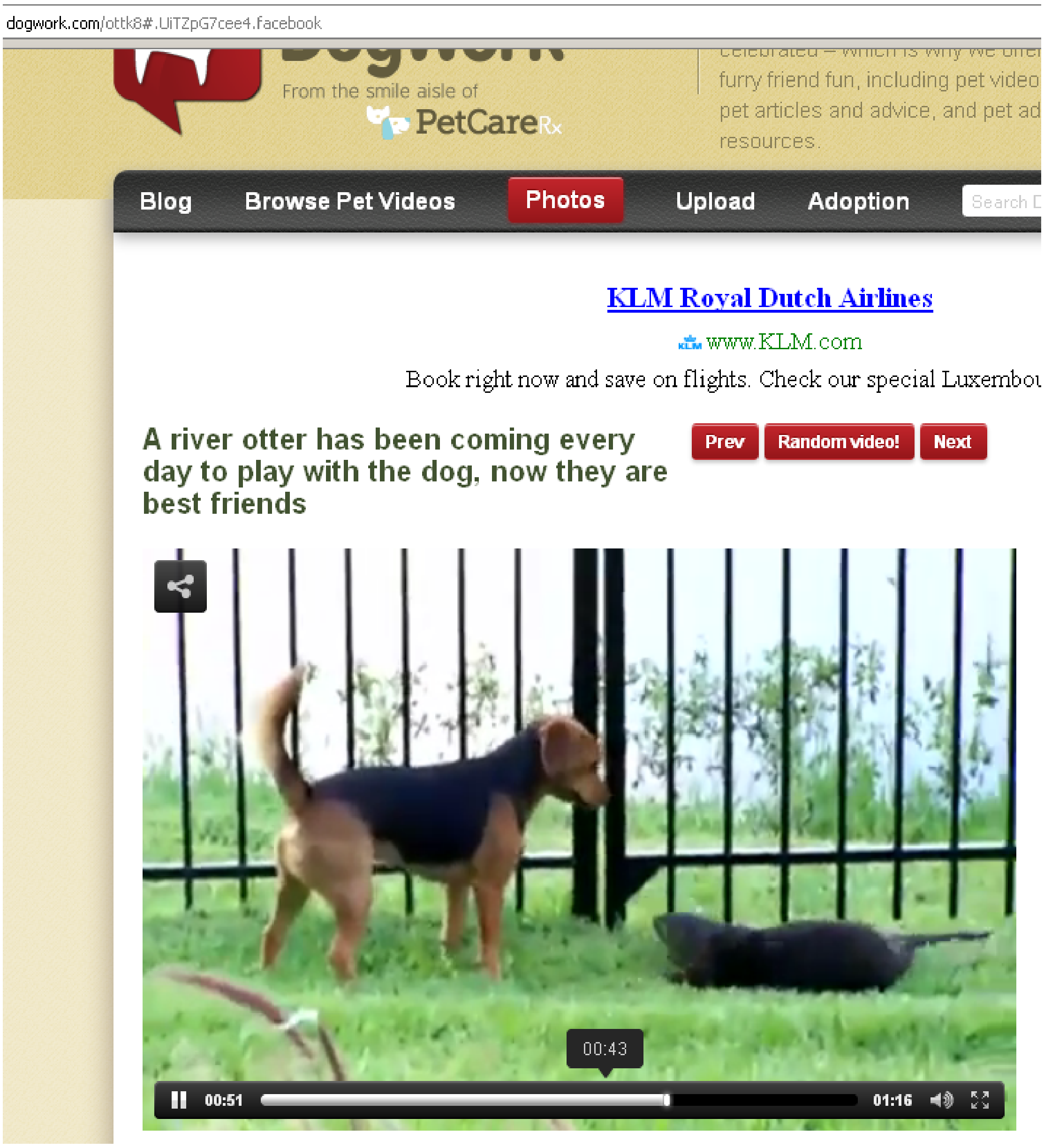
**Robert Elmer, United Kingdom:** I am currently undertaking an undergraduate research project at Cardiff University Otter Project. I am investigating the effect of contaminant levels, including Dieldrin and PCBs, on the Bone Mineral Density of otter bacula.

**Marina Schweizer, Brazil:** My father studied giant otters in the Pantanal, and I have followed him. With my husband, I now run a small ecotourism business on the Rio Negro, working with our guests to record behavioural observations of our resident group of giant otters.

**Anna-Marie Tennant, United Kingdom:** I am happiest outside watching the many wonders of the natural world. Otters hold the top spot. When I am not busy trying to learn more about this fascinating creature I am busy drawing sketches of them. I am very committed to knowledge exchange and am working with otter professionals to develop educational materials about otters and their conservation.

**Heather Wood, United Kingdom:** I am a research assistant with Cardiff University Otter Project (CUOP). I am involved in day-to-day management of CUOP and am also undertaking a research project investigating the prevalence of *Toxoplasma gondii* in otter populations.

## VIRTUAL OTTER




http://www.youtube.com/watch?v=J2jnEBrMkTA