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Study on the Home Range of the Resident Female Otter (*Lutra lutra*), (Carnivora, Mammalia) in South-East Bulgaria

***Dilian G. Georgiev*[1]**

[1] Department of Ecology and Environmental conservation, Faculty of Biology, University of Plovdiv, Tsar Asen St. 24, BG-4000 Plovdiv, Bulgaria; e-mail: diliangeorgiev@abv.bg

Abstract: The home range of the otter (*Lutra lutra*) was studied for the first time in Bulgaria. The approximate home range of one resident female otter in the region under study was 2.2 km bank side of an artificial lake, 6.0 km river length, and 2.5 km canal length. The home range parts mostly preferred for placing the marking sites were the ones with vegetation cover, soil banks and no pollution. Different combinations of a complex of negative factors were essential for avoidance of scat marking by otters in the study area. Most of the sprainting sites in the study area were situated up to 1 m height above water surface and in the stripe of 1 m towards the bank line in and out of the water. In the otter home range studied, sprainting sites with occasional use were most abundant, followed by those of frequent and intense use. The highest association was computed between the intensively marked sites and the presence of dens. Most dominant sprainting site type was the marking throughout the home range without any specific stimulus considered just "marking the home range". Ten different substrates used for marking over were defined in the region. In the study area the dens registered were always placed in the root systems of tree species. During the study period 2 active dens always occurred.

Key words: *Mustelidae*, habitats, marking sites

Introduction

The home range size of otter (*Lutra lutra* (Linnaeus, 1758)) and its use varies in relation with the habitat type and with a variety of limiting factors such as food supply, human disturbance, pollution, vegetation cover, and climate conditions (Sokolov, Rojnov 1979, Mason, Macdonald 1986, Mason 1995, Kemenes, Demeter 1995, Sidorovich 1995).

The ecology of otter in Bulgaria is poorly known (Spiridonov, Spassov 1989, Peshev *et al*. 2004). Our aim was to investigate the size and structure of the home range of resident female otter with the other individuals which temporarily inhabit it (Erlige 1967, 1968) and their habitat and environmental preferences for marking in the study area, and to represent a model, which could be used in the future monitoring programme for the species in the country. We also wanted to throw some light on the problem of the meaning of the marking activity, which is still not clearly elucidated (Chanin 2003a). Otter's marking sites (the so called "sprainting sites") are prominent terrestrial sites at specific locations through their home ranges where animals deposit their scats ("spraints") (Kruuk 1992) and are often used for species monitoring (Chanin 2003b, Mason, Macdonald 2004).

Study Aea

The area of study was situated mostly in the town of Stara Zagora (South-East Bulgaria, UTM grid: LH80, LG89, LG99). It was placed in a park ranging

on the slopes of the Sredna Gora Mountain and the Upper Thracian Valley and consisted of the Bedechka River, Zagorka artificial lake and an irrigation canal. The altitude rises from about 130 m to 300 m a. s. l. at its ends. The area was divided into eight stretch units, characterized by specific conditions. Totally 27.2 km of bank side of running waters and artificial lake were studied when considering both banks of the stream (stream length: 14.7 km).

1. Upper stream of the river in the mountain slope. Partly situated in the town. Steep or relatively steep rocky or gravel banks, low disturbance, dense tree vegetation, sometimes dense bush vegetation, too. Maximum river width 7 m, and depth up to 1.5 m. Not freezing in winter. Border area with not closely situated female otter ranges (the closest was about 6 kilometers away, straight line). Totally 4.0 km of stream length were studied.

2. Artificial lake in the park: soil bank parts with tree and bush vegetation. Relatively steep soil banks, very high disturbance, sometimes even late in the night, dense tree and littoral vegetation, but poor bush one. Water surface about 0,025 km^2. Freezing in winter. The total bank side length was 1.0 km.

3. Artificial lake in the park: cement bank parts without tree and bush vegetation. Relatively steep cement banks, the same level of disturbance as № 2, no tree, bush or littoral vegetation. Water surface about 0.047 km^2, freezing in winter. The total bank length was 1.2 km.

4. Downstream the river in the park. Flattened soil banks dominated, but steep banks were also present, very high disturbance, but mainly during the day, always dense tree vegetation with patches of densely flooded forest vegetation and one flooded part with dense littoral vegetation. Maximum river width 20 m, and depth up to 2.0 m. Not freezing in winter. The total stretch length was 1.5 km.

5. Downstream the river, flowing into a cement canal. Situated also in the town. Flattened cement banks, twenty-four hours disturbance, no dense vegetation, some parts with patches of bush or tree as *Salix* - species. The maximum river width was 3 m, and its depth up to 0.5 m. A proper migration corridor toward the south, connecting with the canal, which crosses the same river's parts out of the town. Not freezing in winter. The total stretch length was 1.3 km.

6. A river polluted downstream with soil bank in plane. Partly situated in the town. Steep canalized soil banks, high disturbance, moderate tree and bush cover (mainly *Salix* species), visible pollution present. Not freezing in winter. Border area with not closely situated female otter ranges (the closest was over 10 kilometers away downstream). The total stretch length studied was 1.2 km.

7. Cement bank irrigation canal out of the town**.** Steep cement banks, moderate disturbance, poor tree and bush vegetation. Maximum canal width 3-4 m, and depth up to 1.5 m. Partly freezing in winter. A proper migration corridor toward the east. Border area with the most closely situated other female's otter range: the diffuse marking on the borders of it started after a kilometer, and was situated mainly on canals east from the town. Total 3.5 km of the stretch were studied.

8. Cement bank irrigation canal in the town. Steep cement banks, twenty four hours disturbance, absence of tree and bush vegetation. Not freezing in winter. Totally 1.0 km of the stretch was studied.

Material and Methods

A home range of one female otter was studied for nine years (1996-2005). The footprint measuring method of Sidorovich (1991) was used to define the area inhabited by one resident animal. The whole home range was studied by walking on banks and when the marking stopped on the border areas, an extra route of 1 km was undertaken to ensure the absence of otter's signs.

The home range area was studied during different seasons of the year to avoid the effect of seasonal variability of seasonal marking intensity (Mason, Macdonald 1986). The sprainting sites were signed and counting of spraints and anal gland secretions was made. A sprainting site during this study in the statistics we considered all sites registered (definition for it according to standard criteria, Mason, Macdonald 2004), no matter of the time of its existence.

Tracks of juveniles and subadult animals (possibly the female's grown cubs) were often found in the area and also the ones of an adult male (footprint measurements according the adapted method of Ottino, Giller 2004). The adult female otters are known to spend their time mainly at standing waters providing more food and shelter (about 70% of their time), but adult males are mostly restricted to the bed of the main river in the catchment, having larger home ranges (Green *et al*. 1984), females with juvenile cubs prefer the upstream of the rivers, and the ones with grown litters - the downstream (Ruiz-olmo *et al*. 2005). According to the length of the study period and the short life of otters in the wild (Hauer *et al*. 2002), we suppose that the first resident female was replaced once by another one during the investigation. The long study period allows to avoid the effect of different habitat selection and the varying of the sprainting intensity during the female's breeding cycle (Prigioni *et al*. 1995, Ruiz-olmo *et al*. 2005). This provides data on the use of the territory as a whole for the marking.

The sprainting sites were characterized by the following parameters: 1. position – height above water surface and placing towards the bank line (out or in the water), when 1 m unit was considered; 2. frequency of use, i. e., the cumulative number of scats and anal gland secretions counted at each site during a two-year period (Quadros, Monteiro-Fihlo 2002): occasional use (one to eight scats), frequent use (nine to 17 scats), intense use (over 18 scats); 3. type of the marking site, considering different importance for the otters' environmental characteristics according to the papers of Vladimirskaia *et al*. (1953), Erlinge (1967, 1968), Vaisfeld (1973), Rostain *et al*. (2004): pools/floods, feeding sites, shelter places – under bridge/tunnel areas, dens, sharp elbows of the stream, tributaries; 4. substrate of the marking site (material for marking over), marking on the snow was not considered, because of the short snow cover period (maximum about 2 weeks) in the region during the study, and in such cases the substrate under the snow cover was marked. Sometimes use of more than one substrate was registered. In such cases the long study period provided which one was the target for marking (the most used one) and only it was recorded. Using the sprainting sites by other carnivores for marking was also signed. The association between the marking sites intensity of use and the other parameters was calculated by the similarity index of Sorensen (Dajo 1975):

$$S = 2c/a + b * 100$$

where: c-number of sites characterized by the two of indications studied, a - total number of sites with first indication, b - total number of sites with second indication.

Habitat preference (PI) for marking was determined using the index of Robel *et al.* (1970):

$$PI = OUPi/HAPi$$

where OUPi is the observed proportion of marking sites in each habitat expressed as number of sprainting sites found in each habitat over the total number of sites (for the whole 9-year period), and HAPi is the proportion of kilometers studied from each habitat over the total number of kilometers studied (Carugati *et al*. 1995) (represented for both banks as a whole for the river and the canal, and for a single bank for the lake).

The density of sprainting sites was calculated for 200 m of bank side length for the lake and for stream length for the running waters.

The home range was measured and the marking sites were localized using GPS (model E-Trex Summit, Garmin).

Results and Discussion

The approximate home range length of a resident female otter in the region measured was 2.2 km bank side of an artificial lake, 6.0 km river length and 2.5 canal length (total 8.5 km of running waters length). We consider the marked area was a little bit prolonged by non-resident animals (for example the dispersing cubs) or when the resident explored outer areas and the most used area by the female resident was slightly smaller.

I. Habitats and the otters' preference for placing marking sites (Table 1).

1. Upper stream of the river in the mountain slope. Otter signs were found up to 3 km upstream

above the artificial lake. All of the sprainting sites found were occasionally marked, mostly stones were used. The preference index was low and also the number of sites/200 m.

2. Artificial lake in the park: soil bank parts with tree and bush vegetation. Otter signs were found on the most of its bank side length. The marking sites density was high and this area was evidently preferred for marking.

3. Artificial lake in the park: cement bank parts without tree and bush vegetation. The habitat was avoided for marking. No marking sites were found during the study period, but a rare use of this habitat was registered by tracks. The possible main reason for the poor marking activity was the lack of hiding sites and the constant human presence. May be because of the bank structure this part of the lake was also not suitable for hunting. Such unfavourable areas are poor in otter signs, but in fact they are a part of the home range when they are placed inside it (Ruiz-Olmo *et al*. 2001).

4. Downstream the river in the park. Otter signs were found along the whole of its length and the segment was the most preferred part of the home range for placing of marking sites. The sprainting sites were with various intensity, type and substrate.

5. Downstream the river, flowing into a cement canal. In the whole stretch otter's signs were registered. The sprainting sites registered were with low density. A low preference for placing the marking sites was recorded here. The low water quantity could be one of the factors for the low preference for marking considering the fact that such shallow waters are rarely inhabited by otters (Mason 1995, Georgiev 2005).

6. Polluted with soil banks downstream the river in the plane. This was the poorest area of sprainting. Marking was registered only along the first 200 m after the unpolluted canalized part of the stretch. The lowest marking site density was found here. The otter activity is often negatively influenced by water pollution (Mason 1995).

7. Cement bank irrigation canal out of the town. Sprainting sites density was a little bit lower than the similar bank type canalized river part, but the preference for marking was similar. The main reasons for the higher preference for sprainting than the other two border parts of the range (number 1 and 6) was probably the absence of strong pollution and the closely situated home range of other resident female: characteristics not present in other border areas.

8. Cement bank irrigation canal in the town. This part of the canal was completely avoided by otters and never any otter's signs were found in spite of not strongly polluted waters. The lack of hiding sites is an essential factor for habitat avoidance not only for the European otter (Anoop, Hussain 2004).

II. Marking Sites (Table 1 and 2). Totally 58 different marking sites were registered and studied during the period of investigation.

1. Positioning. Most of the sprainting sites were situated up to 1 m above water surface. The stripe of one meter along the bank line (in and out of the water) provided most of the sprainting sites registered when horizontal position was studied.

2. Intensity of using. In the otter home range studied, most numerous were spraiting sites with occasional use, followed by those of frequent and intense use.

When similarity index was computed in order to compare with the other types of indications, the following results were obtained (Table 2): over 50 % of similarity we registered between intense marking and areas around dens, substratus of tree roots and soil and position 2 to 3 meters in the water towards bank line. Under 50 % similarity was computed for 9 from the criteria, and a lack of similarity for 12. Frequently used marking sites were not associated highly with other indications and 16 of them had levels of similarity under 50 %, and the rest were without any one. Occasional sprainting sites were most similar (over 50 %) with the placing up to one meter above water surface and in the water up to 1 meter towards bank line and marking throughout the home range without any specific stimulus.

3. Marking site type. Sprainting sites in the area studied were clearly defined and only once co-existence of two indications chosen was found: a root system of a tree above the den was marked and was used as a feeding platform. In this case in the calculations a

Table 1. Results from the different parameters study on the marking sites in the resident female otter's home range. Legend: RU – Upstream the river in the mountain slope; ALSB – Artificial lake in the park: soil bank parts; RDP – Downstream the river in the park; RDCB – Downstream the river, flowing into cement canal; RDSP - Polluted with soil bank downstream the river in the plane; CBCO – Cement bank canal out of the town; n – number of sites registered. The stretch units with no any otter sprainting sites were not included in the table.

№	Transects Characteristic/index	RU (4.0 km)		ALSB (1.0 km)		RDP (1.5 km)		RDCB (1.3 km)		RDSP (1.2 km)		CBCO (3.5 km)		Total (14.7 km)	
		n	%	n	%	n	%	n	%	n	%	n	%	n	%
	height from water surface														
1.	0 to 1 m	5	8.6	10	17.2	20	34.5	6	10.3	1	1.7	8	13.8	50	86.2
2.	1 to 2 m	2	3.4	-	-	1	1.7	-	-	-	-	5	8.6	8	13.8
	horizontal position														
3.	in the water up to 1 m	3	5.2	2	3.4	8	13.8	3	5.2	1	1.7	4	6.9	21	36.2
4.	in the water, 1 to 2 m	1	1.7	2	3.4	1	1.7	-	-	-	-	-	-	4	6.9
5.	in the water, 2 to 3 m	-	-	1	1.7	1	1.7	-	-	-	-	-	-	2	3.4
6.	on the bank up to 1 m	2	3.4	5	8.6	11	19.1	3	5.2	-	-	4	6.9	25	43.1
7.	on the bank, 1-2 m	1	1.7	-	-	-	-	-	-	-	-	5	8.6	6	10.3
	intensity of use														
8.	occasional	7	12.1	5	8.6	16	27.6	3	5.2	1	1.7	8	13.8	40	69.1
9.	frequent	-	-	2	3.4	2	3.4	3	5.2	-	-	4	6.9	11	19.1
10.	intense	-	-	3	5.2	3	5.2	-	-	-	-	1	1.7	7	12,1
	marking site type														
11.	marking the home range	2	3.4	6	10.3	11	19.0	4	6.9	-	-	6	10.3	29	50.0
12.	pool/flood	3	5.2	-	-	7	12.1	-	-	-	-	1	1.7	11	19.0
13.	feeding site	-	-	1	1.7	-	-	-	-	-	-	-	-	1	1.7
14.	under bridge/tunnel	1	1.7	-	-	1	1.7	2	3.4	-	-	3	5.2	7	12.1
15.	den	-	-	2	3.4	2	3.4	-	-	-	-	-	-	4	6.9
16.	sharp elbow of the steram	1	1.7	-	-	-	-	-	-	-	-	2	3.4	3	5.2
17.	tributary	-	-	1	1.7	-	-	-	-	1	1.7	1	1.7	3	5.2
	substrates														
18.	cement bank	1	1.7			1	1.7	1	1.7	1	1.7	8	13.8	12	20.7
19.	stone	6	10.3	2	3.4	3	5.2	1	1.7	-	-	5	8.6	17	29.3
20.	sand	-	-	-	-	1	1.7	-	-	-	-	-	-	1	1.7
21.	soil	-	-	-	-	-	-	1	1.7	-	-	-	-	1	1.7
22.	dead trunk	-	-	5	8.6	2	3.4	-	-	-	-	-	-	7	12.1
23.	trunk of live tree	-	-	-	-	5	8.6	-	-	-	-	-	-	5	8.6
24.	tree roots with soil	-	-	3	5.2	1	1.7	1	1.7	-	-	-	-	5	8.6
25.	grass	-	-	-	-	4	6.9	-	-	-	-	-	-	4	6.9
26.	tire	-	-	-	-	3	5.2	2	3.4	-	-	-	-	5	8.6
27.	nylon	-	-	-	-	1	1.7	-	-	-	-	-	-	1	1.7
	total marking sites	7	12.1	10	17.2	21	36.2	6	10.3	1	1.7	13	22.4	58	100
	marking sites/200 m	0.4		2.0		2.8		0.9		0.2		0.7		0.8	
	preference index (PI)	0.3		2.9		4.0		1.1		0.1		1.0		-	

Table 2. Similarity index (S, %) calculated between the intensity of marking and the other characters of the spraint-ing sites (the numbers corresponds with those in Table 1). Legend: IM – intensity of marking, I – intense marking, F – frequent marking, O – occasional marking.

	Sprainting site characteristics																							
IM	1	2	3	4	5	6	7	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
I	21	13	0	0	50	38	0	0	11	0	14	73	0	20	11	8	0	0	0	0	67	25	0	0
F	30	21	13	0	15	33	24	25	0	13	33	0	14	14	35	14	0	0	17	25	0	0	19	0
O	78	21	79	18	0	40	47	70	39	0	13	0	9	5	27	26	7	7	26	13	7	14	18	5

priority was given to the more constant during time indication (den), and the occasional one (feeding site) was ignored. Accordingly we consider that one marking site could have more than one function and recommend careful study of these criteria.

The most dominant were the sprainting sites without any visible stimulus for marking, and were considered just "marking the home range". The other types were under 50 % of occurrence from all registered.

4. Substrates of the marking site. Various substrates for sprainting over were registered in the region (Table 1). The utilization of the stones and cement banks dominated. Use of substrates with an anthropogenic origin also was found: old car tires and nylon remains.

5. Changing the marking site or originating of a new one. According to various studies (Sokolov, Rojnov 1979) of otter sprainting sites have been constantly used by different animals for long years. In this study we represent data for changing or originating of some sprainting sites during the nine-year period. The first reason for a change was replacing the den, when after it and the site for marking accompanying. During the study period 2 active dens were always registered: one at the lake and one at the river in the park. When these changed, the marking site on the lake bank was frequently marked after, and the possible reason was the nearest river flow, a preferred part for marking in areas of standing waters (Georgiev 2005), but when the den in the river site (which had no other stimulus for marking) changed, marking on the site immediately stopped. In the second case changing the marking sites appeared when 3 sites on the canal bank were totally ignored after a tunnel built above the canal away from them (but closer to the river site) and new 3 sites appeared under it. Tunnels and bridges undersides are known as preferred shelter places by otters (Chanin 2003). When most of the otter spraints were removed from an intensively marked site under the tunnel and left above it, a new marking near them was registered after few days and also one scat of a rock marten (*Martes foina* Erxleben, 1777) was deposited. After cleaning the site from the spraints, no more marking was registered there (this experimental case was not included in the calculations).

6. Other carnivores' marking on sprainting sites. Using of four of the otter sprainting sites (four occasional times) by other carnivores for scat marking was registered: 1 site of polecat (*Mustela putorius* Linnaeus, 1758), 1 of rock marten (*Martes foina*) and 2 of red fox (*Vulpes vulpes* Linnaeus, 1758) – all in the cement bank canal stretch.

III. Dens. During the study period 2 active dens always occurred: one at the lake and one at the river in the park, but each one of them was once removed (see: II. Marking sites). The only reason during the two times was destruction of the tree: the one on the lake bank dried and fell, and the other at the river was cut. All dens registered were in the root system of trees: the first on lake's bank in *Populus* sp., the second in *Carpinus betulus* ones, all the dens at the river site were in roots of *Salix alba*. All entrances of the holes at the lake part of the range were under water and those at the river – above. There were 3 entrances of the first and 2 of the second river site den, all 17 to 20 centimeters wide. The underwater entrances were registered, but not measured. According to the facts mentioned and the presence of more favourable conditions for cubs growing signed at the lake (no risk for flooding and access to a good food supply, accepting Liles 2003) we consider that the breeding site was placed there.

Conclusions

1. The approximate home range length of resident female otter in the region measured was 2.2 km bank side of an artificial lake, 6.0 km river length and 2,5 canal length (totally 8.5 km of the running waters length).

2. The home range parts mostly preferred for placing the marking sites were the ones with a vegetation cover, soil banks and no pollution. At the border areas, mostly preferred stretch was also the one with the most closely situated home range of other female resident otter.

3. Different combinations of a complex of negative factors (high disturbance, scarcity of hiding sites, inappropriate bank structure, high pollution, low water quantity, unfavourable landscape for migration, distant home ranges of other females) were essential for avoidance of marking by otters in the study area.

4. Most of the sprainting sites in the study area were situated up to 1 m above water surface and in the stripe of one meter along the bank line in and out of the water.

5. In the otter home range studied, most abundant were sprainting sites with occasional use, followed by those of frequent and intense use.

6. The highest association was computed between the intensively marked sites and the presence of dens. Also for the occasional marking the sites and placing them close up to 1 m to the bank line, up to 1 m height and marking throughout the home range without any specific stimulus.

7. Sprainting sites' types in the area studied were clearly defined. Most dominant sprainting site type was the marking throughout the home range without any specific stimulus, considered just "marking the home range".

8. Ten substrates used for marking were observed in the area, with preference for marking on the stones and cement banks. Using of substrates with anthropogenic origin was also found.

9. Stopping the use of a given marking site in the area was caused by disturbing the stimulus for sprainting or when more favourable site for marking originated nearby.

10. Marking could be provoked on a never used by otters site, when replacing spraints from its traditional sprainting sites.

11. Sprainting sites in the region studied were rarely used for scat marking by other carnivores.

12. In the study area the dens registered were always placed in the root systems of tree species (*Populus* sp., *Carpinus betulus*, *Salix alba*).

13. During the study period 2 active dens always occurred: one at the lake and one at the river in the park and each of them was removed once because of destruction of the tree.

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Изследване върху индивидуалния участък на една резидентна женска видра (*Lutra lutra*), (Carnivora, Mammalia) в Югоизточна България

Д. Георгиев

(Резюме)

За пръв път е изследван индивидуалният участък на видрата (*Lutra lutra* L.) в България. Приблизителният индивидуален участък на една женска видра резидент от района на изследване е 2,2 km брегова ивица на изкуствено езеро, 6,0 km дължина на речен участък и 2,5 km дължина на канал. Най-предпочитаните части от индивидуалния участък на видрата за разполагане на маркировъчните места са тези с наличие на естествени брегове от почва и отсъствие на замърсяване на водата. Различни комбинации от комплекс негативни фактори са вероятната причина за избягването на участъци от територията за маркиране. Голямата част от местата на маркиране са разположени до един метър височина от водната повърхност и на същото разстояние спрямо бреговата ивица към сушата и във водата. В изследвания индивидуален участък на видра най-често срещани са случайно маркираните места по отношение на интензивността на използването им, следвани от тези с често и интензивно използване. Най-често интензивно маркираните места са асоциирани с наличие на убежища. Най-често срещаният тип маркировъчно място е с ниска интензивност на маркиране и без наличие на видими стимули за маркировъчно поведение. Десет различни субстрата са използвани за маркиране върху тях. В изследвания район дупките на видрата винаги са разположени в кореновата система на дървесни видове и в индивидулния участък на женския индивид присъстват две активно използвани такива.