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OBSERVATION OF EURASIAN OTTER'S DIEL ACTIVITY USING CAMERA TRAPPING IN CENTRAL-EASTERN ROMANIA

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Observation of Eurasian Otter's Diel Activity using Camera Trapping in Central-Eastern Romania. Bouroş, G., Ionescu, D. T., Hodor, C. — The observation of elusive mammals, is still problematic, particularly in flowing waters or wetlands. But with the usage of camera traps, it was possible to obtain valuable information about otters. The aim of this study was finding the diel activity of the otters that live in Central-Eastern Romania. The diel activity of the Eurasian otter along its habitat was studied from March 2011 to April 2016 over 1356 days & nights of camera trapping. The camera traps have recorded a total of 222 otter visits at all 10 observation sites. Otters, passing through the observation sites, were strongly nocturnal and displayed a trimodal diel activity pattern, one occurring just before dawn (between 04:00 and 06:30 h), the second one occuring just after dusk (between 18:30 and 22:00 h) and the third one occurring in the middle of the night (between 00:30 and 01:30). Otters have been also active during the Civil Twilight (7.2 %), more active during the dusk (5 %) than during the dawn (2.3 %). Seasonally the Eurasian otters were more active during winter (39.6 %) and progressively less active in spring (31.5 %) summer (9 %) or autumn (19.8 %).

Key words: *Lutra lutra*, nocturnal, activity patterns, camera trap.

Introduction

Which is the diel activity of otters, are they nocturnal animals, or active in daytime? It might be both of them, even individuals from the same species, but in some regions, they are definitely more diurnal than nocturnal. Why it's nocturnal? This nocturnal behaviour has little to do with disturbance from people, as is often thought, however otter's nocturnal behaviour is primarily related to the availability of prey and fish behaviour (Kruuk & Moorhouse, 1990, Carss et al., 1990).

Salmonids and many other freshwater fish are often inactive during the night, waiting still on the bottom of the water (Westin & Aneer, 1987) and are presumed to be more vulnerable to otter's predation then.

Some Eurasian otters have an intense diurnal activity, as it can be seen in the observations made by Hans Kruuk on the otters (*Lutra lutra*) of Shetland. There, the otters showed one clear peak of activity just before midday in winter, but in summer the activities like: swimming and foraging was spread throughout the daylight hours, with one main peak early in the morning and a lesser one in late afternoon (Kruuk, 2006). This daytime activity is in contrast to Eurasian otters which are nocturnal elsewhere (Chanin, 1985; Kruuk, 1995; Mason & Macdonald, 1986). The most appropriate explanation for this lies in the activity of the otters' main prey species: the fishes.

How to study the behaviour of Eurasian otters (*Lutra lutra*) which are largely nocturnal, solitary and elusive? (Macdonald & Mason, 1994; Lerone et. al., 2011). Most knowledge about this species is obtained from indirect signs, such as footprints and spraints. While most behavioural and activity patterns are difficult to understand from direct observation, it were used camera traps to observe the diel activity of the otters.

There are numerous studies that suggest that Eurasian otters are nocturnal in their range (Chanin, 1985; Mason & Macdonald, 1986; Kruuk, 1995; Kruuk, 2006; Chanin, 2013), even in Romania (Georgescu, 1989; Cotta & Bodea, 1969; Manolache & Dissescu, 1977; Murariu & Munteanu, 2005), however none of them studied this nocturnal behaviour in detail. Some studies proofed that otter is mainly nocturnal using radio telemetry (Green & Jefferies, 1984) or infrared counting systems (Garcia de Leaniz et al., 2006) only in UK, in rest of otter's distribution range the evidence for this is lacking. Such a study was absolutely necessary, for conservation reasons, because in many regions of Romania and not only, the local population is unaware of the presence of the otters, due to their night-time behavior are very rarely observed. Thus not knowing the existence of otters in certain areas, no conservation measures are taken for this species when developing infrastructure projects that may affect aquatic habitats. Using camera traps technology it was possible to study the diel activity of the otters in Romania by analysing the capturing date and time of the images and videos of the otters captured by the camera traps.

The techniques used in this study involved little intrusion into the otters' habitat and no significant disturbance to the study animals. Hence, data generated non-intrusively by infrared camera traps represent an improvement over other, more intrusive observing methods that relied on the trapping and tagging of individuals, or the periodic removal of scented spraints (Kruuk et al., 1986), used for territorial marking (Kruuk, 1992).

Although the method that we used is not an invasive method we observed that animals are aware of the presence of cameras and easily avoided them.

Moreover, as data are gathered and stored remotely with little human supervision, image capture systems provided a powerful and cost-effective alternative for observing otter activity in remote areas, where other techniques might be unsuitable or too expensive (Cutler & Swann, 1999).

The need for such a study arises not only from a necessity to understand the behaviour of this endangered semiaquatic carnivore, for understanding the factors that determine its behaviour (human disturbance, prey availability), but also to meet a need for knowledge to establish best measures for otter's conservation management by finding the diel activity of the otters that live in Central-Eastern Romania.

Material and methods

The study was conducted in three Natura 2000 protected areas from Central-Eastern Romania: Site of Comunity Importance Lower Siret Valley, Putna Vrancea Natural Park and Ramsar Site Dumbravița Fishpond Complex (fig. 1).

Lower Siret Valley NATURA 2000 Site, is located in north-east of the Romanian Plain (Long. E 27.342499 Lat. N 45.772777), in the lower sector of Siret River. The surface of the Site is 250.81 km² with an altitude varying between 0 m to 302 m. The Siret river is the most important river from Romania after Danube, it has a lenght of 706 km (596 km in Romania and 110 km in Ukraine) and its average discharge is 250 m³/s. The camera traps were installed on a small tributary of Siret River, that has a lenght of 12 km.

The most important riparian habitats are: the alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*, the groves with *Salix alba* and *Populus alba*, alluvial meadows grasslands with *Cnidion dubii*, riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, and muddy banks with *Chenopodion rubri* and *Bidention*.

The Lower Siret Valley is very rich in ichthyofaunal diversity, some of the main fish species found here are: *Abramis ballerus, A. brama, A. sapa, Acipenser ruthenus, Alburnoides bipunctatus, Alburnus alburnus, Anguilla anguilla, Aspius aspius, Barbus barbus, B. petenyi, Blicca bjoerkna, Carassius carassius, C. gibelio, Chondrostoma nasus, Cobitis danubialis, C. taenia, Ctenopharyngodon idella, Cyprinus carpio, Esox lucius, Eudontomyzon danfordi, Gobio albipinnatus, G. kessleri, G. obtusirostris, Gymnocephalus cernuus, G. schraetzer, Hypophthalmichthys molitrix, H. nobilis, Idus idus, Lampetra planeri, Lepomis gibbosus, Leucaspius delineatus, L. leuciscus, Lota lota, Misgurnus fossilis, Neogobius fluviatilis, Orthrias barbatulus, Pelecus cultratus, Perca fluviatilis, Phoxinus phoxinus, Proterorhinus marmoratus, Pseudorasbora parva, Pungitius platygaster, Rhodeus sericeus amarus, Romanogobio kessleri, R. vladykovi, Rutilus carpathorossicus, Sabanejewia aurata, S. balcanica, S. vallachica, Scardinius erythrophthalmus, Silurus glanis, Squalius cephalus, Stizostedion lucioperca, Tinca tinca, Vimba carinata, Zingel streber* and *Z. zingel* (Battes et al., 2005).

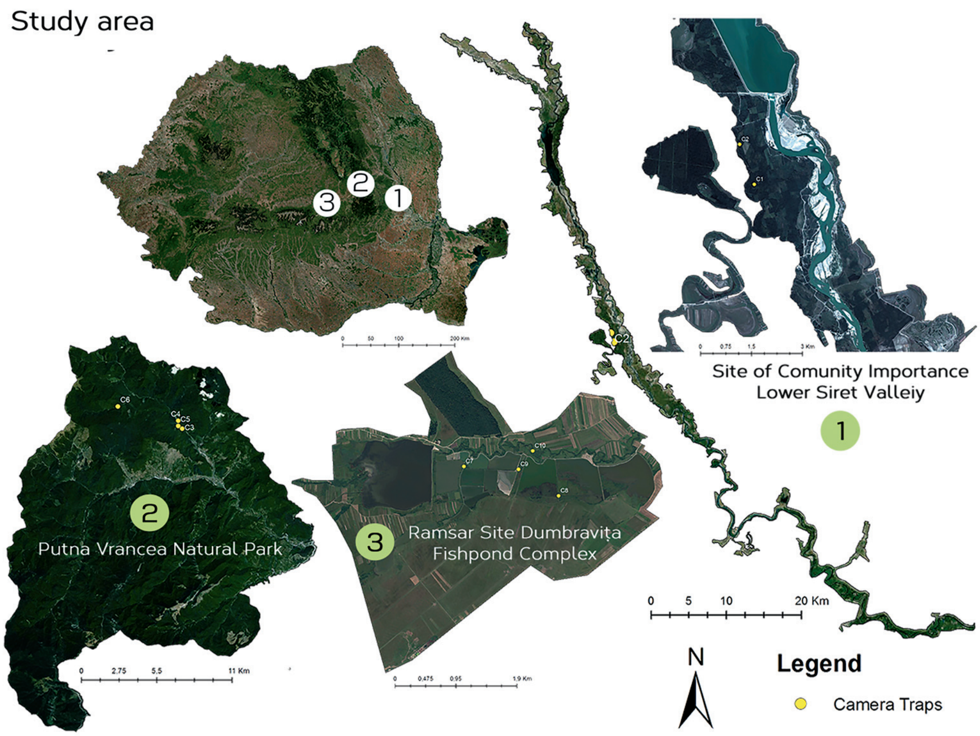

Fig. 1. The study area.

The Putna Vrancea Natural Park is found in eastern Romania (Long. E 26.503436 Lat. N 45.921461) and covers an area of 382.13 km², with altitude ranging from 435 m a. s. l. in the valley of the Putna River to over 1785 m a. s. l. in Goru Peak. Riparian habitats consist mainly in woods of alder (*Alnus glutinosa*, *Alnus incana*). The Camera traps were placed on Lepșa River, a tributary of Putna River that has a lenght of 16 km and an average flow of less than 1 m³/s.

Fish fauna is not rich and is generally composed of: *Salmo trutta fario, Oncorhynchus mykiss, Cottus gobio, C. poecilopus, Eudontomyzon danfordi, Phoxinus phoxinus, Nemachilus barbatulus, Thymallus thymallus, Barbus meridionalis petenyi, Gobio uranoscopus, Alburnoides bipunctatus* and *Lota lota*.

Ramsar Site Dumbravița Fishpond Complex is placed in central part of Romania (Long. E 25.473898 Lat. N 45.762829), covers an area of 4.14 km² of which 3.5 km² are aquatic habitats, composed of ponds and canals. A complex of man-made wetland consists in reservoirs and fishponds surrounded by crops, meadows, dense emergent vegetation with reedbeds, marsh areas and wet grasslands. The types of characteristic wetland vegetation are represented by: reed (*Phragmites australis*), bulrush (*Typha latifolia*, *T. angustifolia*), various sedges (*Carex* spp.), the forest vegetation is scarce.

The fish species in this area are predominantly those of economic interest: *Perca fluviatilis, Carassius gibelio, Cyprinus carpio carpio, Cyprinus carpio, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis, Alburnus alburnus, Abramis brama, Scardinius erythrophthalmus, Squalius cephalus* and *Gymnocephalus cernua*.

These three protected areas have different habitats that support a rich biodiversity and that make this sites an important places for Eurasian otters.

Ten observation sites from all three protected areas were selected and observed for 1356 days & nights between March 2011 to April 2016. Camera traps (Moultrie Game Spy I45 Infrared Digital Game Camera 4.0 MP and Bushnell 8MP Trophy Cam Standard Edition) with Invisible IR-Flash were placed in the selected otter observation sites at about 0.5 metres above the ground and attached to firm structures such as tree stems and stumps from otter's habitat.

Two cameras have been installed in Lower Siret Valley NATURA 2000 Site (C1 & C2) at the longest distance between them at 3 km, four cameras have been placed in Putna Vrancea Natural Park (C3, C4, C5 & C6) at the longest distance between them at 6 km and other four in Ramsar Site Dumbravița Fishpond Complex (C7, C8, C9, C10) at the longest distance between them at 1,5 km.

The cameras were camouflaged and hidden as much as possible leaving enough room for the lens, motion sensor and infrared projector.

The places were camera traps, were set was mainly on the otter's marking sites or on the otter's paths, which are usually frequented by a few individuals that have a common border in the individual home ranges.

For the study it wasn't used scent lures or any kind of bait in order to not change or influence otter's behaviour and activity.

The camera traps were also set to register the correct date and time and for each shot the date and time information were recorded at the base of each picture or video.

The camera model used in this study have a PIR sensor. Studies made in Italy have registered a small number of otters with the camera with PIR sensor. The Italian authors consider that the reason is smoothed temperature between the body of the otter and the environment — water. Despite the correct positioning of the traps in terms of angle set and the ascertained transit of otters at the site, proved by the presence of fresh scent markings, after a total of 150 days/trap, they did not obtain any videos or photos of otters (Lerone et. al., 2011). Being aware of these facts, we registered also videos when otters were emerging directly from the water and we manage to capture 222 otter visits, at all 10 observation sites, for a total of 1356 days/trap. We confirm that all visits to the observation sites could not be recorded, even if they were confirmed by fresh faeces and traces, due to the ineffectiveness of the PIR sensor, because the body temperature of the otter emerging from the water is too low to activate the PIR sensor.

Information from each camera were analyzed to look for temporal detection patterns. The main aim of the study was to find the diel activity of the otters that live in Central-Eastern Romania.

Results

The camera traps have recorded a total of 222 otter visits at all 10 observation sites. An otter's recording was defined as the detection of an otter by a camera trap.

Camera traps were functional for 97.2 % of the study period due to technical (memory card and battery) issues. The overall otter trap success rate for all cameras was 14.6 % of diel capture (DC), but some of the cameras had higher trap succes: C5 (33.3% DC), C2 (32.1% DC), C9 (21.9 % DC), C1 (17.9 % DC), followed by lower trap succes cameras: C4 (13.3 % DC), C6 (12.5 % DC), C10 (12.3 % DC), C8 (6.7 % DC), C3 (4.7 % DC) and C7 (1.7 % DC) (table 1).

Most of the otter recordings came from the two cameras placed in Lower Siret Valley (64 %) followed by the camera traps installed in Dumbravița Fishpond Complex (31 %) and Putna Vrancea (5 %).

Eurasian otters were strongly nocturnal and few (2.7 %) otters were recorded after 07:30 h or before 17:30 h GMT+2. Most of the otters were recorded during the night (86.5 %) and only 6.3 % of the otters were crossing the observation sites during the day. Otters have been

Table 1. Trap succes rate overall cameras

Camera	Operating periods	No. diel	No. otter captures	No. diel dysfunction	No. diel otter capture	Succes rate, %
C1	25.11.2014–23.04.2016	515	101	0	92	17.9
C2	08.01.2016–23.04.2016	106	40	0	34	32.1
C3	30.04.2015–28.09.2015	151	7	2	7	4.7
C4	05.03.2011–10.03.2011/ 12.08.2011–20.08.2011	15	2	0	2	13.3
C5	01.11.2013–03.11.2013	3	1	0	1	33.3
C6	26.01.2013–10.03.2013	43	1	35	1	12.5
C7	25.10.2015–20.02.2016	118	2	0	2	1.7
C8	11.10.2015–12.04.2016	193	13	0	13	6.7
C9	18.10.2015–21.03.2016	155	47	0	34	21.9
C10	12.02.2016–09.04.2016	57	7	0	7	12.3
Total		1356	221	37	193	14.6

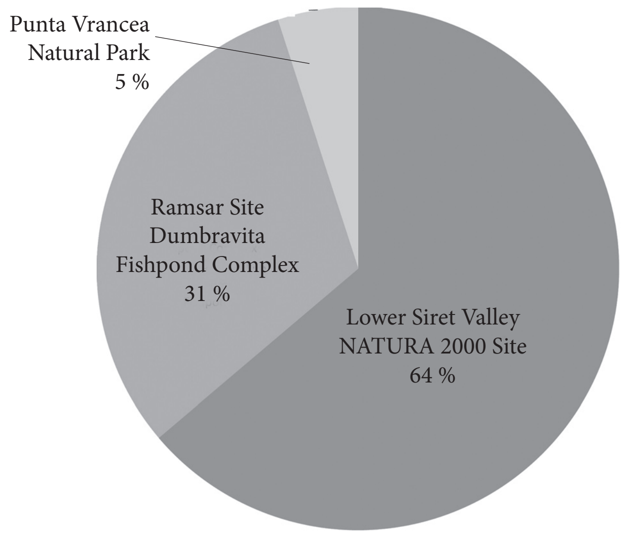

Fig. 2. General diel activity of otters in the study area.

also active during the Civil Twilight (7.2 %), more active during the dusk (5 %) than during the dawn (2.3 %) (fig. 2).

There were similarities concerning the hours of diel activity of Eurasian otters between the three study areas and there were identified three peaks of otter activity that were evident: one occurring just before dawn (between 04:00 and 06:30 h), the second one occuring just after dusk (between 18:30 and 22:00 h) and the third one occurring in the middle of the night (between 00:30 and 01:30). The period when otter inactivity was more distinctively was during 09:00–16:00 hours (fig. 3). Otters were more diurnal during late winter (February) and early spring (March and beginning of April) than in the summer or autumn, 78.6 % of the otter diurnal activity recordings are from February to April (fig. 4).

Otter's main activity period was variable according to the season, and strongly correlated with the darkness time: spring (18:30–07:00), summer (20:00–06:00), autumn (18:30–06:30), winter (16:30–07:30), all this indicated that the otters were strongly nocturnal in their behaviour (fig. 4).

Seasonally the Eurasian otters were more active during winter (39.6 %) and progressively less active in spring (31.5 %), summer (9 %) and increasing again their activity in autumn

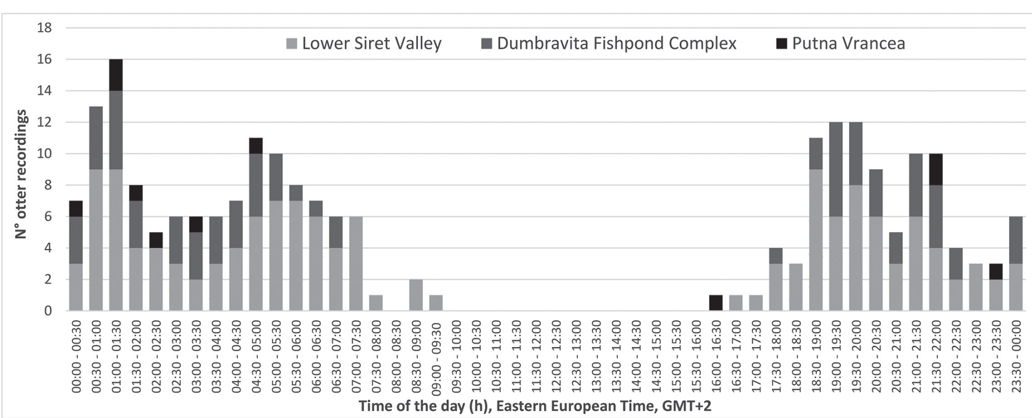

Fig. 3. The activity pattern of the otter in the three protected areas, based on the number of otter recordings at the observation sites during March 2011–April 2016.

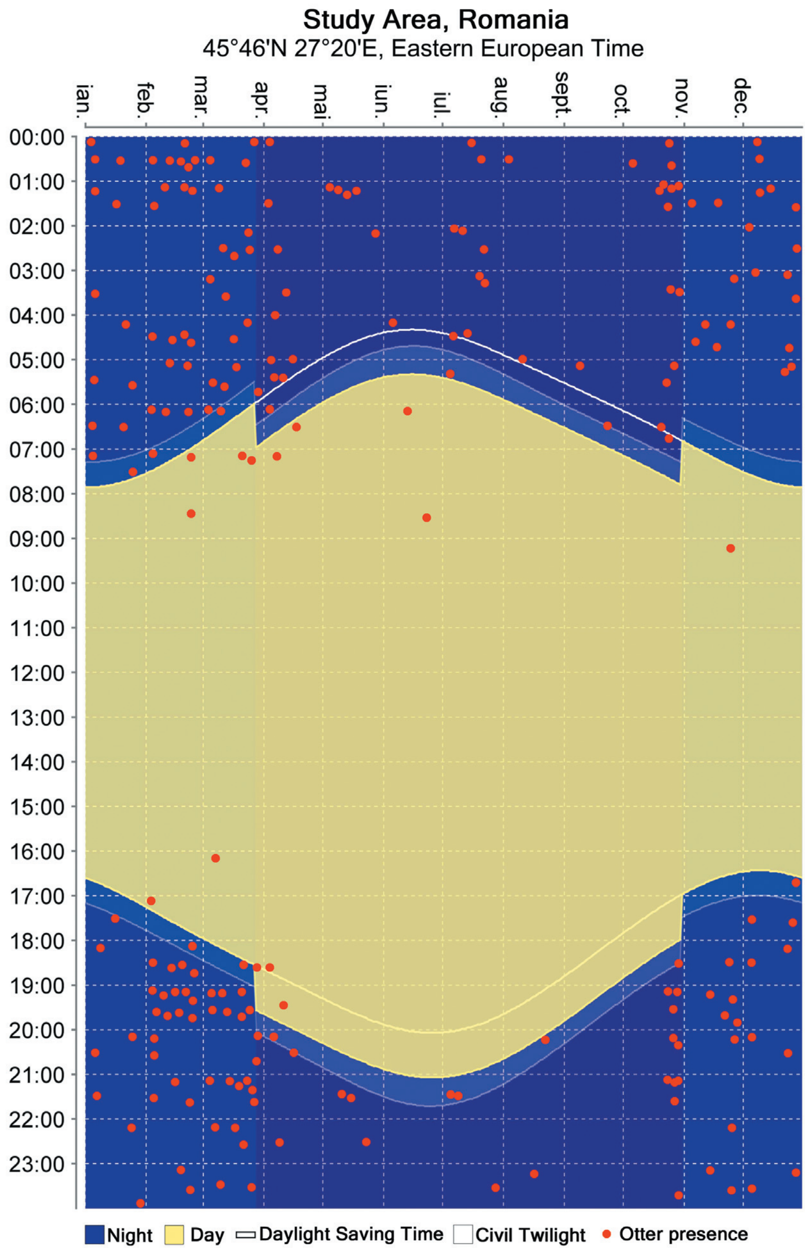

Fig. 4. Otter recordings, correlated with local time and day-night graph.

(19.8%) (fig. 5). The low activity of the otters detected by camera traps during the summer and autumn is caused by the small difference between the temperature of the wet otter's body and the environment, during the warm season the performance of PIR is worst than during the cold season (winter and spring) when there are higher differences between the body temperature of otter and temperature of environment (Kuhn & Meyer, 2009).

Analysis of night activity patterns of the otter (fig. 6) grouped at monthly intervals indicated a strong seasonal trend in the three protected areas. Most of the otter activity was concentrated in February (19.8 %) and March (19.3 %) and lowest activity was registered in September (0.9 %) and June (1.3 %). From May to September, during the warm season, the

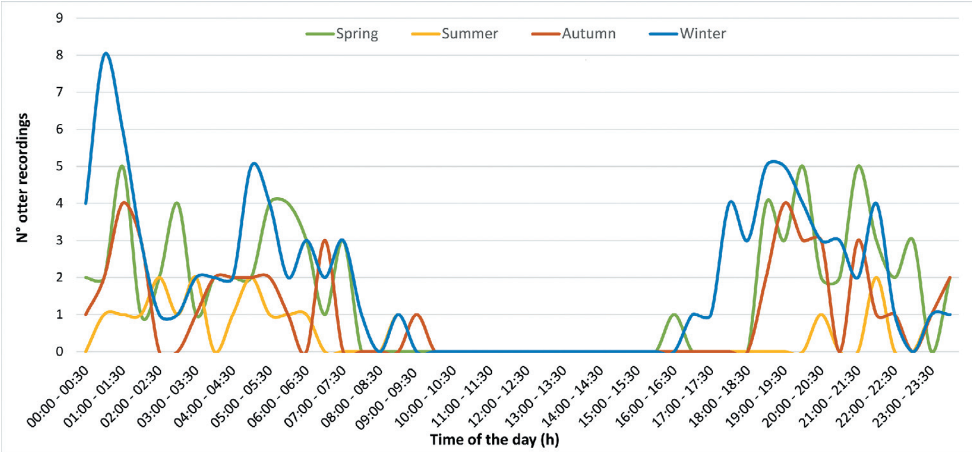

Fig. 5. Seasonal variation of otter activity pattern in study area during March 2011–April 2016.

otter activity is very low in the observation sites area and is increasing since the starting of the cold season (October). During the warm period otter's wet body temperature is almost the same as the environment, and the PIR sensor, often fail to detect the otter's presence. This fact it is confirmed by the presence of otter signs (fresh scats and tracks) at the observation sites during the warm season, but without any new record on the cameras.

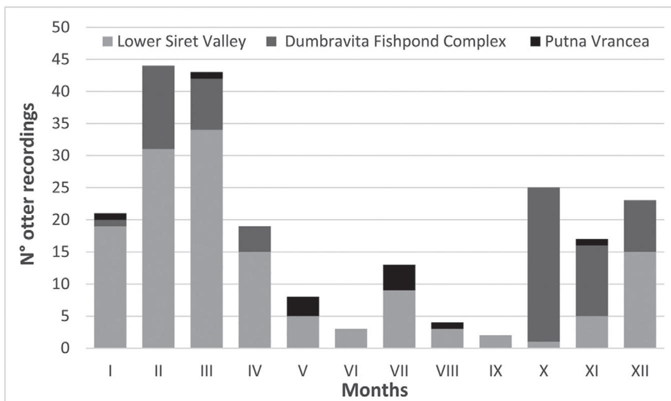

Fig. 6. Seasonal activity patterns of *Lutra lutra* in the study area during the study period based on the number of otter crossings through the observation sites.

Discussions

The night activity seems to be the most common for most of the mustelids, as otters, followed by crepuscular activity, and continued with diurnal activity wich is much less common (Gittleman, 1986).

Many carnivores species from Europe exhibit a nocturnal behaviour and the semi-aquatic carnivores like otters are among them. Eurasian otters were described as nocturnal (Macdonald & Mason, 1983; Chanin, 1985) while in some other areas they may be diurnal, as example the Eurasian otter on the Shetland coast (Kruuk, 1995).

The research made on otters in temperate freshwaters environment from United Kingdom have shown that they are indeed mainly nocturnal or crepuscular. Most of the studies recorded, that the longest periods of otter's night activity began at sunset and lasted three to five hours (Green et al., 1984; Carss et al., 1990; Garcia de Leaniz et al., 2006).

There are some factors that influence the activity patterns of the mammalian carnivores, and some of them are: diel temperature variation (Schmidt-Nielsen, 1983), interference from competitors (Carothers & Jaksic, 1984), limitations of the visual system (Walls 1963; Dunstone & Sinclair 1978), risk of predation (King 1975), social behaviour (Ewer 1973; Gittleman, 1986), and behavioural thermoregulation (Chappell, 1980). However, what makes carnivores unique is the fact that their foods, unlike that of herbivores, have their own circadian cycles of availability and vulnerability (Curio, 1976; Zielinski, 1986). Other variations in the activity patterns of carnivores are largely influenced by numerous other factors such as periodicity resulting from physiological changes (Sollberger, 1965), synchrony in diel activity between predator and their prey (Melquist & Hornocker, 1983), climatic conditions of the area, the types of habitats in which they live, and the degree of human interference. Since there are so many factors that might influence the activity patterns of the otters, it is difficult to determine the role of innate physiological rhythms of otters. Any one of these factors, may have had an overriding effect on others (Melquist & Hornocker, 1983). However, in this study, it was observed that the Eurasian otters exhibited a pronounced nocturnal activity all through the year, which was more intense in winter and spring than in summer and autumn.

Several studies have suggested that over most of the Eurasian otter distribution range, their activity is eventually limited by disturbance and persecution from humans and that is why otters respond by being largely nocturnal (Mason & Macdonald, 1986). An alternative explanation, and one which is turning out to be progressively trust worthy in the light of studies from an extensive variety of ecological disciplines, is that otter nocturnal behaviour is primarily related to the accessibility to prey species (Kruuk & Moorhouse, 1990; Carss et al., 1990).

The main die1 cycle of rising and setting of the sun imposes a dramatic and overriding set of predictable constraints on the behaviour and activity of fishes (Helfman, 1986).

Salmonids and many other freshwater fish are often inactive during the night, waiting motionless on the bottom of the water (Westin & Aneer, 1987) and are presumed to be more vulnerable to otter predation then (Kruuk & Moorhouse, 1990).

One basic theme common to several fish studies in different habitat types discussed by Helfman is the risk of fish predation during twilight. The ‚quiet period' (Hobson, 1972), when neither diurnal nor nocturnal fishes are truly active is a time of major activity for predatory fishes (Hobson, 1968; Major, 1977) and also for Eurasian otter according the results of this study 7.2 % of otter recordings occured during twilight. The changing levels of light during twilight, and the increased activity of predators at that time, suggests a direct link between vision and predation during crepuscular periods. Both diurnal and nocturnal fishes have eyes better matched to prevailing wavelengths during twilight than to night-time conditions. Twilight active piscivorous fishes possess intermediate eyes which function poorly, relative to the visual capabilities of potential prey, during the day or night but may function better than either a diurnal (photopic) eye or a nocturnal (scotopic) eye during twilight (Carss, 1995). But otters by dilating their pupils accommodate rapidly to changes in light levels, at dawn and dusk and so may have an advantage over fishes which are visually impaired by the transformation between photopic and scotopic vision (Munz & Mcfarland, 1973). Furthermore, the fact that in freshwater otters catch their fish mostly in the depth of night also suggests that eye sight is of only secondary importance. As a support of this idea, Hans Kruuk has captured in one box trap from a small river in Scotland a large adult male Eurasian otter that was completely blind (white opaque eyes) and in excellent physical condition, demonstrating that its disability had little effect on its foraging success: it used tactile stimuli. Few is known about the visual acuity of otters underwater; it appears to be less than in air (Kruuk, 2006).

The seasonal activity of otters in this study appears very similar to results of other studies from UK freshwater habitats based on infrared counter technology of the otters (Garcia de Leaniz et al., 2006) and derived from the intensity of sprainting for otters (Kruuk, 1995), all of this studies showing an activity typically peaking in the cold season (late autumn, winter and early spring) and decreasing thereafter.

The top of the otter activity in the cold season could be determined also by prey accessibility, the swimming performance of trout and other fishes is extensively decreased at low water temperatures (Hegennes et al., 1993). Moreover, Hegennes & Borgstrom (1988) concluded that salmonid populations were more vulnerable to predation from endothermic predators such as mink *(Mustela vison*) during cold weather and the same might be valid for otters.

Some authors have noted a strong seasonal dependence of UK otters on salmonids, which appears to peak during the autumn (Mason & Macdonald, 1986; Kruuk, 1995) when salmonid spawners may be particularly vulnerable and have associated this peak of otter activity with salmon spawning season (Garcia de Leaniz et al., 2006) the same situation can also occur in Romania with many fish species, but in order to make such correlations are necessary extensive research on the behavior of prey species, which seems to influencing the behavior of the predator.

Under most circumstances human disturbance is not likely to be the main factor influencing otter's activity, and the availability of prey appears to be more important.

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