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Effects of extensive fishpond management and human disturbance factors on Eurasian otter (*Lutra lutra* L. 1758) populations in Eastern Europe

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Abstract. Wetland losses related to human activities in the past decades have caused heavy decline in the population of the Eurasian otter (*Lutra lutra* Linnaeus) throughout Europe. As otters are often used as flagship species for wetland conservation programmes, the understanding of their response to human disturbance and environmental factors is essential to fine-tune conservation tools for managing artificial water bodies. In this study we estimate which wetland characteristics and human factors to what extent drive the spatial distribution of otters. We investigated factors related to the habitat selection of Eurasian otters between December 2004 and January 2007 on 31 fishponds in the Hortobágy National Park, Eastern Hungary. We have shown that otter habitat selection is primarily governed by both disturbance-related characteristics and vegetation properties of fishponds, and not by humans. Moreover, we did not find the effects of artificial fisheries inputs or hunting pressures. Fishponds far from human settlements with large reed islands and dykes with trees are the key habitats for Eurasian otters. However, the presence of adjacent forests and grazing areas negatively affect the otter sign densities in fishponds.

Key words: carnivore, habitat selection, Hortobágy, Hungary.

Introduction

The Eurasian otter (*L. lutra*) is a semi-aquatic mustelid occupying all types of aquatic environments (Prenda & Granado-Lorencio 1996, Duarte et al. 2011), with its distribution covering most of the Palearctic region and part of Southern Asia (Ruiz-Olmo et al. 2002). Although this species has a quite broad habitat tolerance (Ruiz-Olmo et al. 2002), progressive declines of otter populations have been reported in many European countries during the twentieth century (MacDonald & Mason 1994, Mason & MacDonald 2003). Several direct and indirect human disturbance factors have been shown to drive variation in population decline, for example, illegal hunting, road-kill (Janczke & Giere 2011), pollution and habitat fragmentation (Mason & MacDonald 1986). Environmental drivers, such as drought, fish mortalities (Jiménez & Lacomba 1991), as well as bankside quality and steepness of waterside banks may also comprise the key factors in shaping the signs of otter densities (Kemenes & Demeter 1995, Clavero et al. 2005). The importance of these factors varies between regions and might be influenced by a number of combined effects (Chanin & Jefferies 1978). In Hungary, the Eurasian otter was protected since 1974 by national laws and in 1982 it was declared as a strictly protected species (Lanszki et al. 2007). However, otter populations are more stable in this region than in the western part of the continent (Reuther et al. 2000), as larger numbers of fishponds are found in Central-European countries. Specifically, artificial fish-pond systems cover 30.000 hectares in Hungary (Heltai 2002), providing vast habitats and ample food for otters throughout the year.

Although factors affecting habitat preference of different otter species have been widely studied (Green et al. 1984, Kruuk et al. 1995, Durbin 1998, Anoop 2001, Shenoy 2002, Remonti et al. 2008, Mirzaei 2009, Conroy and Jenkins 2011), habitat use assessed through direct observation is limited because it is only possible in a few habitat types, for instance in freshwater wetlands (Fumagalli et al. 1995, Kruuk 1995, Ruiz-Olmo et al. 2005a, Pizarro Neyra 2008, García 2011). Conversely, studies based on otter signs (Perinchery et al. 2011) such as tracks and spraints, revealed the importance of water current speed, river's depth and width, shelter availability and landscape characteristics (Bedford 2008, Kruuk 1995, Barbosa et al. 2001, Ottino & Giller 2004, Ruiz-Olmo et al. 2005b).

Vegetation characteristics of wetlands play a key role in shaping the spatial distribution of otters (Prenda et al. 2001, White et al. 2003, Shenoy, Varma & Devi Prasad 2006, Urban et al. 2010). Specifically, otters seem to be attracted by forests alongside wetlands. Further, a number of studies have described the importance of the presence of potential holts that are also related to vegetation features (Ottino & Giller 2004, Ruiz-Olmo et al. 2005a) and how food availability, especially fish biomass and density affect otter distribution (Sjoåsen 1997, White et al. 2003, Medina-Vogel & Gonzales-Lagos 2008).

However, there is an accumulating body of evidence indicating that the disturbance factors related to human activities, such as road type (McMahon & McCafferty 2006), presence of humans (Prenda et al. 2001, Shenoy et al. 2006), as well as hunting disturbance (Jamnickỳ 1995, Cortés et al. 1998), tourism (Barbosa et al. 2001) and human population densities (Cortés et al. 1998) may strongly influence the spatial distribution of otter activities. For example, water pollution (Delibes et al. 2012), considered as an indirect effect of enhanced human population densities (Mason & MacDonald 1986), possibly limits the habitat availability of otters (Cortés et al. 1998). Further, Barbosa et al. (2001) suggested that although human variables may have less influence on otter distribution, these can be more disruptive than natural environmental factors. In this paper we focus on the habitat selection of the Eurasian otter in a wetland complex harbouring one of the densest otter populations located in the Hortobágy National Park, Eastern Hungary (Gera 1996). As large wetlands and stable water bodies are disappearing due to human-induced habitat loss and climatic change (Fox 2007), fishponds represent increasingly important habitats for otters (Lanszki & Körmendi 1996, Lanszki et al. 2010). Because this type of wetland is basically regulated according to the requirements of industrial fish farming and stochastic economical processes, otters do not necessarily find optimal food availability and neccessary water levels in a spatial network of semi-stagnant natural wetlands and fishponds throughout the year. Accordingly, in this study we calculate the dependence of otter sign densities on management type, human disturbance factors as well as structural and landscape characteristics effecting on ecological scales relevant to prior knowledge on the habitat use of otters.

We aim to determine the extent to which different factors affect habitat selection, and to formulate suggestions for practical conservation management. Specifically, we intend to infer conservation implication issues for fishpond management technologies.

Materials and Methods

Study area

The study area is located in the north-eastern part of Hungary (47°30′N; 21°0′E), characterised by complexes of alkaline and Pannonic loess steppe and wetlands. The most important environmental factors driving landscape dynamics in grasslands are wind, flood and fire (Ecsedi et al. 2004). However, after the regulation of the River Tisza, wetlands of this region can only be artificially flooded. Most of the natural and semi-natural habitats are protected by Hungarian national laws and international agreements. The study area is part of the Hortobágy National Park, which is the oldest and largest coherent protected area of Hungary covering 82,000 hectares with 27,000 hectares protected under the Ramsar Convention. Furthermore, the national park is an Important Bird Area (IBA) and belongs to the Natura 2000 network both as a Special Protected Area (SPA) and a set of Special Area of Conservatin (SAC).

As a partial compensation for the loss of natural wetlands, extensive systems of fish-farms were built in the central part of the Hortobágy during the first two decades of the 20th century. As a result of this effort, fishponds presently cover a total of 6000 hectares, with six of the fishpond units located inside the study area, covering 3000 hectares. Fisheries inside the study area consist of 31 ponds with surface areas ranging between 8 and 470 hectares (see Tabe 1.). After the regulation of the River Tisza, the importance of these artificial ponds for sustaining wetland flora including endangered aquatic plant species has been increasing. Moreover, extensive water-surfaces of these artificial habitats are crucial for mammals and migratory birds. The shorelines of the ponds are predominantly covered by reed beds forming floating and fixed reed islands. Fishpond vegetation is characterised by littoral marshes (Phragmito-Magno-Caricetea class) dominated by reed (*Phragmites australis*), sea clubrush (*Bolboschoenus maritimus*), lesser reedmace (*Typha angustifolia*) and Laxmann's reedmace (*Typha laxmanni*), forming a highly seminatural habitat composition. Floating aquatic vegetation (Potamea class) consists basically of water chestnut (*Trapa natans*), fringed water lily (*Nymphoides peltata*) and pondweed (*Potamogeton nodosus*), with sparse occurrences of water lily (*Nymphaea alba*) and yellow water lily (*Nuphar lutea*). Fishponds are cultivated extensively and managed by a state-owned fish-farm. Ponds are primarily disturbed by road traffic next at Akadémia,

Table 1. Fishpond sizes inside the study area.

Pond system	Pond ID	Pond size (ha)	Open surface area (ha)	Reed cover (ha)
Halastó	I.	142	186	82
	II.	128		
	III.	142	102	167
	IV.	128		
	V.	125	16	111
	VI.	142	126	18
	VII.	142	109	34
	VIII.	142	109	31
	XI.	166	126	32
	XIV. (Kondás)	470	268	135
	Wintering	4	4	0
Fényes	I.	28	23	5
	II.	44	42	3
	III.	60	52	9
	IV.	65	47	22
	V.	33	30	3
	Wintering	12	12	0
Csécs	I.	53	32	21
	II.	64	41	25
	III.	107	75	20
	IV.	57	47	11
	V.	113	80	21
	VI.	58	45	13
	VII.-VIII.	131	70	49
Borsós	-	135	-	-
Akadémia	I.	8	5	1
	II.	27	23	3
	III.	26	25	3
	IV.	26	19	5
	Breeding ponds	27	27	0
Gyökérkút	VI.	75	58	33
	VII.	18	21	5
	VIII.	31	20	12
	IX.	42	37	6
	X.	115	84	32
	XI.	104	57	16
	Wintering	4	4	0

Borsós, Fényes and Gyökérkút fishponds. On the other side, units of the Öregtó-fishponds are predominantly affected by trail traffic, and the ecotourism as well as by reed harvesting during winter. Because of harvesting technology, ponds are periodically drained and refilled (Appendix I). The most abundant fish species farmed in the ponds are common carp (*Cyprinus carpio*), silver carp (*Hypophtalmichtys molitrix*), giebel (*Carassius carassius*), grass carp (*Ctenopharyngodon idella*), pike (*Esox lucius*) and catfish (*Silurus glanis*), which are the main prey items of the otters inhabiting these fishponds (unpublished data). Other potential preys of the otter include a number of species of water beetles (*Dytiscus marginalis*), anurans (*Anura spp.*), European pond turtle (*Emys orbicularis*), birds, and muskrat (*Ondatra zibethicus*).

Data collection

We collected data between December 2004 and January 2007, performing monthly surveys on all pond dykes, which are the only topographical features were otter signs can be collected in pond systems. Surveys were conducted between 8 a.m. and 16 p.m. following a standard line transect. During each survey we recorded the location of old and fresh spraints, tracks, food remains as well as trails on 1:10,000 geographical maps (Ruiz-Olmo et al. 2005, Marcelli & Fusillo 2009, Prenda et al. 2011, Almeida et al. 2012). Although spraint density is not necessarily related to the density of individuals in a linear fashion, it has been applied by a number of recent studies as a reliable measure of otter sign densities (Ottino & Giller 2004). There was a total of 143 days of data collection, amounting to 1,144 hours working time and 2,900

Table 2. Recorded environmental variables.

GIS data	Fishfarm data	Field data	Internet sources
Dyke length (m)	Water depth (m)	Number of trees alongside the dyke	Population size of nearest settlement
Pond size (ha)	Canal output (m3/s)	Minimum slope of pond shore (in steps of 10°)	
Size of pond system (ha)	Number of wintering ponds	Maximum slope of pond shore (in steps of 10°)	
Reed width (m)	Total size of wintering ponds in the pond system (ha)	Minimum slope of canal (in steps of 10°)	
Distance to canal (m)	Number of stocked fish	Maximum slope of canal (in steps of 10°)	
Distance to nearest settlement (m)	Total weight of stocked fish (kg)		
Number of farms in a range of 3 km	Number of caught fish		
Distance to nearest public road (m)	Total weight of caught fish (kg)		
Number of reed-islands	Water level (1: filled up. 2: drained. 3: during filling up. 4: during draining)		
Total coverage of reed islands (ha)	Dyke type (K-outside. B-inside)		
Presence of hunting			
Presence of winter ponds (logical)			
Presence of agricultural area in the vicinity of dykes and canals			
Presence of goose farm in the vicinity of dykes and canals			
Presence of railway in the vicinity of dykes and canals			
Presence of settlement in the vicinity of dykes and canals			
Presence of road in the vicinity of dykes and canals			
Presence of forest in the vicinity of dykes and canals			
Presence of pond in the vicinity of dykes and canals			
Presence of meadow in the vicinity of dykes and canals			

kilometres long routes. The length of standard routes varied between 7-35 km depending on the size of fishpond system (mean = 16.9 km). A trail was classified as an otter trail only if species specific spraints were present. Old and fresh spraints were distinguished by colour and substance (Jay et al. 2008). The presence of anal secretion and food remains were also recorded. After data recording we removed the signs, which does not influence otter behaviour, to avoid double counting. To check the effects of removing otter signs on behaviour, we regularly visited the same spots during the following day. As spraints were regularly replaced, we consider otter behaviour unaffected by sign removal. At each survey we recorded the environmental variables enlisted in Table 2. Descriptive statistics of numeric variables are summerized in Table 3.

Statistical methods

The density of spraints and tracks for each dyke was calculated by dividing the number of otter signs by the length of the dyke. To evaluate the importance of environmental factors in shaping otter sign densities we used Linear Mixed Modelling applying the *lme4* package of the R statistical computing environment (R Development Core Team 2009). During model fitting we employed the density of fresh spraint and track as response variables including the numeric variables as fixed continuous effects. Categorical environmental variables were included as fixed categorical effects in the model. To avoid the possible bias of spatial autocorrelation, fishpond system and dyke were added as random factors, with year and month included as nested random factors. All possible first-order interactions between effects were also fitted. During model fitting we entered and excluded all effects sequentially until only variables explaining significant variation remained. Significance of fixed terms was accepted if $t > 2.00$ (Crawley 2007), following a conservative statistical approach. Significance of effects was also tested by the ANOVA function of the statistical package. All dropped variables were included again in the model to obtain levels of non-significance. We applied the same method to test if significant effects had not been wrongly excluded. The minimal model was derived by removing terms from the maximal model and adding effects to the simplest model (Pinheiro & Bates 2000).

Table 3. Summary statistics of numeric explanatory variables.

Variable	Min	Median	Mean	Max
Number of tracks	0	2	4.87	243
Number of fresh spraints	0	0	1.82	132
Number of old spraints	0	0	1.68	112
Track density (N/m)	0	0	0	0.53
Fresh spraint density (N/m)	0	0	0	0.09
Dyke length (m)	150	1100	1247.21	4800
Pond size (ha)	8	60	81.87	470
Pond system size (ha)	107	754	806.99	1676
Reed zone width (m)	10	80	154.05	920
Pond depth (m)	0.6	1	1.02	1.6
Distance to canal (m)	10	12.5	18.97	50
Canal length (m)	1850	12000	13097.23	20750
Distance to settlement (m)	75	1200	816.23	1500
Number of settlements	23	63	83.39	1400
Number of farms	4	5	5.34	8
Distance to public road (m)	12.5	37.5	774.77	2500
Number of reed islands	0	0	1.04	4
Total area of reed islands	0	0	4.98	57
Number of wintering ponds (m)	0	26	26.53	40
Total area of wintering ponds	0	2.4	7.13	23.6
Number of trees	0	2	3.71	32
Minimum slope of pond dyke	10	30	38.23	80
Maximum slope of pond dyke	10	45	44.1	90
Minimum slope of canal dyke	0	45	45.4	80
Maximum slope of canal dyke	0	50	58.45	90
Number of input fish	0	275	456058.56	8115000
Number of harvested fish	0	0	46939.72	514270
Weight of input fish	0	0	35298.58	811500
Weight of harvested fish	0	0	24251.47	116533
Number of input fish species	0	0.5	2.87	11
Number of harvested fish species	0	0	2.61	11

Results

Phenology of habitat use

During the whole study period, the density of otter tracks varied between 0.000 and 0.533 tracks/m (mean ±SE = 0.004 ± 0.013 tracks/m), whereas the density of fresh spraints ranged between 0.000 and 0.085 spraints/m (0.00±0.005 spraints/m). However, both variables show a marked monthly variation: track densities varied between 0.001 and 0.002 track/m, while fresh spraint densities were between 0.0001 and 0.004 spraints/m.

There was considerable variation in spatial distribution of otter tracks and fresh spraints: track densities ranged between 0.002 and 0.006 tracks/m, while spraint densities varied between 0.0001 and 0.004 spraints/m.

Linear Mixed Model

As track and spraint densities were highly correlated (Pearson's product moment correlation, r = 0.162. p< 0.01), we included only spraint density as response variable in the models. When including the density of fresh spraint as a dependent variable the following fixed effects were found to be significant: total area of reed islands (t= 2.660, Fig. 1), presence of adjacent forest (t=-3.915), presence of adjacent settlement (t= -2.720, Fig. 2) and presence of adjacent grazing area (t=-3.453, Fig. 3.).

In contrast, the number of reed islands was not significantly related to spraint densities (t= 0.650). Although otter spraint densities were not different between areas with and without wildfowl hunting (t= 0.615), note that hunting pressure was relatively low in the whole of the study area. We found no association between spraint densities and the extension of fishponds (t= 1.191) and wetland complex size (t= 0.020). The relationship between spraint distribution and dyke length was not significant, but showed a slightly negative trend (t= -0.077). We have found no effect of fish input on spraint densities, both in the number of fish (t= -1.267) and the total weight of catch (t=

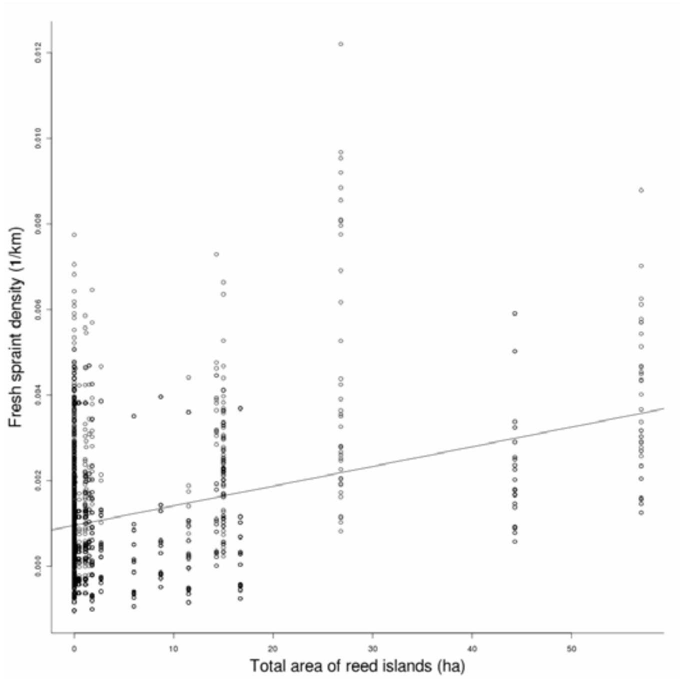

Figure 1. Relationship between spraint densities and total size of reed islands calculated from the Linear Mixed Model controlling for random factors

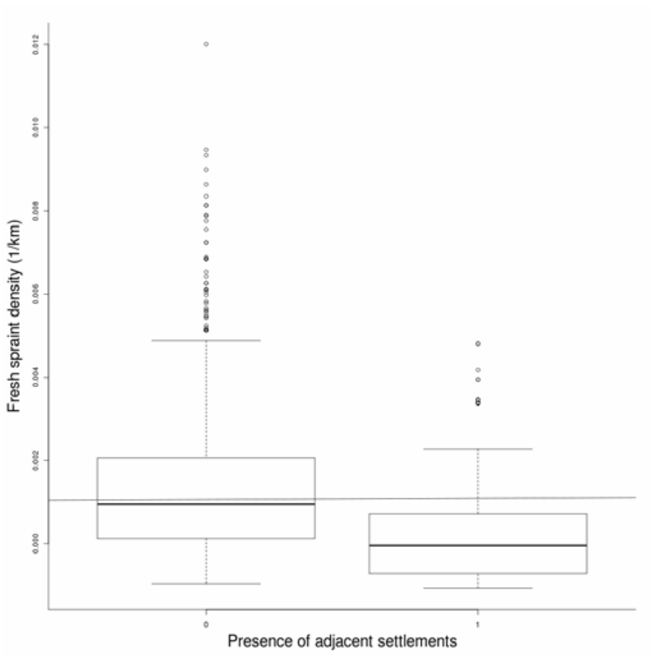

Figure 2. The relationship between fresh spraint densities and presence of human settlement. Notations: 0-without presence of adjacent human settlements; 1-with presence of adjacent human settlements. (Means ± S.E.)

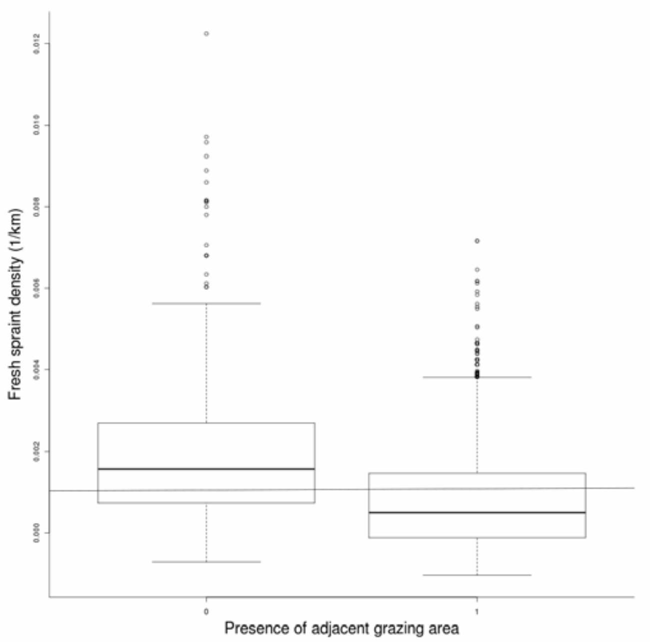

Figure 3. Relationship between fresh spraint densities and presence of grazing area. Notations: 0 - without presence of adjacent human settlements; 1 - with presence of adjacent human settlements. (Means ± S.E.)

1.152). However, the latter variable has shown a positive relationship to otter distributions. Further, we observed no effect of the length (t= 1.266) and carrying capacity (t= 0.798) of canals. No relationship was revealed between spraint distribution and several physical characteristics of fishponds: the number of reed islands (t= 0.650), the maximum slope of dykes (t= -1.350), the number (t= -0.700) and total size (t= -0.352) of ponds wintering of the fish. Despite of the importance of human settlements in driving otter sign densities, we revealed no effect of the distance from them (t= 1.341). This was true for the number of farms in a range of 3 kilometres (t= -0.635). Similarly, we detected no effect of the distance of roads (t= 1.567), presence of adjacent roads (t= 0.235) and railways (t= 0.249). Otters tended to avoid dykes near agricultural areas, but this association was not significant (t= -0.614).

Discussion

Our results revealed that otter sign densities were influenced by the size of reed islands, the density of trees suitable for holts as well as the vicinity of human settlements and the presence of grazed grasslands. Moreover, we found that artificial fish input and hunting pressure do not affect otter sign densities. In contrast with other studies (García-Diaz & Ayres 2011) our findings confirm that large waterbodies can sustain enhanced otter sign densities, probably due to reduced human disturbance as found by Barbosa et al. (2001), and Madsen (2001).We observed that the presence of trees on fishpond dykes might play a key role in shaping the spatial distribution of otter territories, probably driven by increased burrowing possibilities. This conclusion corresponds to previous studies which found that wetland areas with dense bankside vegetation cover are preferred by otters due to increased possibilities for burrowing, playing, and hiding (Georgiev 2005, Georgiev & Stoycheva 2006, Cho et al. 2009, Loy et al. 2009), even in captive populations (Fumagalli et al. 1995). We found that the area of reed islands is an important factor in driving habitat choice of otters, implying that vegetation patches that inaccessible for humans may provide suitable sites for holts. In contrast to some previous study (Ruiz-Olmo et al. 2001, White et al. 2003, Prigioni et al. 2005), we did not detect any relationship between fish input and otter sign densities, which may be a consequence of ample natural food resources in these extensively farmed fishponds (Adámek et al. 2003, Juhász K. unpublished).

Because fishponds of the study area are nearly one hundred years old, part of them are already in a semi-natural state resembling natural marshlands. These wetlands harbour several endangered species, both breeding (Pygmy Cormorant *Phalacrocorax pygmeus*, Spoonbill *Platalea leucorodia*, Bittern *Botaurus stellaris*, Ferrugineous Duck *Aythya nyroca*) and migrating species (Lesser White-fronted Goose *Anser erythropus* and Red-breasted Goose *Branta ruficollis*) (Ecsedi et al. 2004). In addition, perception of physical features (e.g. shape of open surfaces) might influence the habitat selection of otters preferring natural habitats. We suggest that higher otter sign densities were caused by semi-natural state of the fishponds combined with extensive fish farm usage rather than intensively pond management (Adámek et al. 2003).

The relatively small distances between fishpond units can contribute to the stability of food supply. This idea is supported by secretion analysis data showing that the frequency of secondary prey items was not significant (Juhász K. Unpublished). Furthermore, previous studies demonstrated that the degree of wetlands degradation affects the habitat availability of otters avoiding degraded wetland (White et al. 2003). Conversely, otters were shown to avoid shallow marshlands (White et al. 2003, Prigioni et al. 2005), which are the habitats of key conservation value inside the Hortobágy National Park (HNP), some of them are enlisted in SCI appendices. Hence, we conclude that managing extensively farmed ponds are critical for the maintenance of otter populations in areas where natural, large and deep waterbodies of constant water level are lacking. Also, otters being top predators play a vital role shaping the community structure of wetland habitats (Ottino & Giller 2004).

In contrast to some previous studies (Glimmerveen & Ouwerkerk 1984, Kemenes & Demeter 1995, Ayres & García 2011, Gilkinson et al. 2011) we did not demonstrate any effect of water depth on otter occurrences, possibly due to the stability of the water level in those artificial ponds. However, we believe that otters might prefer wetlands of nearly constant depth owing to balanced food availabilities. Similarly to previous studies, we revealed the positive effect of land cultivation (Kemenes & Demeter 1995). Bank steepness did not influence otter sign densities, possibly because dykes are not steep enough to form barriers for otters.

The presence of forrested vegetation in the vicinity of dykes negatively affected fresh spraint densities, probably due to increased human disturbance related to forestry and hunting activities. In our study sites otters avoided dykes in the proximity of human settlements, similar to some previous studies (Carugati & Perrin 1998). This might be partly due to an increased frequency of encounters with stray dogs, based on observations reported in the region (Juhász K. unpublished). The same reason might be employed for the avoidance of intensively grazed areas where dogs occur frequently (Lanszki et al. 2007).

The results revealed that the hunting pressure is not a decisive factor in influencing otter occurrences, as hunting is very limited and strictly controlled in the whole region. However, in non-protected areas with intensive fish-farming, enhanced poaching activities were reported (Lanszki et al. 2007), emphasizing again the importance of wetland protection in otter conservation (Sidorovich & Pikulik 1998).

No evidence of traffic impact on otters habitat selection was found. We suppose that the reasons behind this are: (1) railway traffic was not intensive and might influence only a few sections of dykes, and (2) only a small number of fishpond units were divided by a public road with heavy traffic. However, several road killed otters were reported from these areas in the past few years (Juhász K. unpublished). As our study area is situated in a relatively undisturbed region where hiding is not likely to drive most of the variation in otter occurrence, there was no evidence to support the hypothesis that otters prefer thick reed beds suggested by some earlier studies (McCafferty 2005).

Conservation implications

We observed that artificial food supply did not influence otter sign densities, therefore we recommend to use extensive fishpond technologies (slow fish production on larger surfaces) that would decrease the damage caused by otters in fish stocks. This will be useful in semi-natural habitats where otters find a larger variety of natural food (Bodner 1995, Lanszki & Körmendi 1996, Kloskowski 2005, Mirzaei et al. 2010, Schmidt et al. 2012). This can also reduce conflicts between conservationists and farmers (Myšiak et al. 2004). This is a possible explanation of why local fish farmers tolerate the presence of otters in contrast to the presence of fish consuming birds (e.g. Great Cormorant *Phalacrocorax carbo*, Grey Heron *Ardea cinerea* and Black-headed Gull *Larus ridibundus*), which is an important issue in the current economic conditions.

Our results emphasize the importance of wetland management for otters inside protected areas due to general wetland degradation in non-protected areas. Moreover, we suggest that wetland maintenance is a key aspect of habitat management because otters avoid human settlements. Although Hungary still holds a relatively stable otter population compared to neighbouring countries due to its large number of fishponds (Lanszki & Körmendi 1996), conflicts between fish farmers and conservationists have regularly been reported, sometimes even poaching were recorded (Lanszki 2007). As poaching cannot be effectively controlled in private fishponds, we propose the use of extensive fish-farming technology in non-protected areas to improve otter conservation and at the same time avoid otter-related damages. Ongoing communication between fisheries, governmental and non-governmental organizations should be started on a European level to ensure a more effective coexistence of otter populations and commercial interests, because otter populations are declining in an alarming rate in Western Europe (Gera 1996). Similar to Fernandez-Morán et al. (2002), we propose to use otters as flagship species in semi-natural wetlands, as these habitats often harbour a number of endangered species. However, caution should be employed on the validity of considering otter as an umbrella species in Central-European wetlands, because large densities of otters were rarely detected in habitats of community importance (Natura 2000) or Ramsar sites (Bifolchi & Lodé 2005).

Although human pressure related to outdoor activities in protected areas has been reported as a key disturbance factors for wetlands (Beale & Monaghan 2004) our results do not support the prediction that ecotourism negatively affects otter habitat choice.

Our results also demonstrated that trees on dykes represent a key factor for habitat selection in otters, supporting the importance of creating tree lines. In addition, a raised variety of bankside vegetation may provide a wider palette of prey items for otter populations.

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+ Appendix I (1 page)

Appendix I. Pond status during the study (1: filled up, 2: drained, 3: under refilling, 4: under draining).

		State of pond																							
		2005												2006											
		01.	02.	03.	04.	05.	06.	07.	08.	09.	10.	11.	12.	01.	02.	03.	04.	05.	06.	07.	08.	09.	10.	11.	12.
Akadémia	I.	1	1	1	2	3	1	1	1	1	1	1	1	1	1	1	4	3	1	1	1	1	1	1	1
	II.	1	1	1	2	3	1	1	1	1	1	1	1	1	1	4	4	3	1	1	1	1	1	1	1
	III.	2	2	1	1	1	1	1	1	1	1	4	2	2	2	2	2	3	1	1	1	1	1	1	1
	IV.	1	1	4	2	3	1	1	1	1	1	1	1	1	1	4	3	1	1	4	3	1	1	1	1
Gyökérkút	X.	1	1	1	1	1	1	1	1	1	4	2	2	2	3	1	1	1	1	1	1	1	1	1	1
	XI.	1	1	1	1	1	1	4	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	IX.	2	2	2	3	1	1	1	1	1	1	1	1	1	1	1	1	4	3	1	1	1	1	1	1
	VII.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	VIII.	1	1	1	1	1	1	1	1	1	4	4	2	2	2	3	1	1	4	4	3	1	1	1	1
	VI.	1	1	1	1	1	1	1	4	4	3	1	1	1	1	1	1	4	3	1	1	1	1	1	1
Borsós		1	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Fényes	I.	1	1	1	1	1	1	1	1	4	4	2	2	2	3	1	1	1	1	1	1	1	1	1	1
	II.	1	1	1	1	1	1	1	1	1	4	4	2	2	3	1	1	1	1	1	1	1	1	1	1
	III.	1	1	1	1	1	1	1	1	1	3	1	1	1	1	4	2	3	1	1	1	1	1	1	1
	IV	1	1	1	1	1	1	1	1	1	4	2	2	2	2	3	1	1	1	1	1	1	1	1	1
	V.	2	2	2	3	1	1	1	4	2	2	2	2	2	2	3	1	1	1	1	1	1	1	1	1
Csécs	I.	1	1	1	1	1	1	1	1	1	1	4	2	2	2	3	1	1	1	1	1	1	1	1	1
	II.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	3	1	1	1	1	1
	III.	1	1	1	1	1	1	1	1	1	4	3	3	1	1	1	1	1	1	1	1	1	1	1	1
	IV.	1	1	4	3	1	1	1	1	4	2	2	2	1	1	1	4	4	3	1	1	1	1	1	1
	V.	1	1	1	1	1	1	1	1	1	4	3	3	1	1	1	1	1	1	1	1	1	1	1	1
	VI.	1	1	1	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	VII.-VIII.	1	1	1	1	1	1	1	1	4	4	3	3	1	1	1	1	1	1	1	1	1	1	1	1
Halastó	I.-II.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	3	1	1	1	1	1
	III.-IV.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	V.	2	2	2	2	2	2	2	2	2	2	2	2	1											
	VI.	1	1	1	1	4	4	2	2	2	2	2	2	2	3	1	1	1	1	1	1	1	1	1	1
	VII.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	VIII.	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	XI.	1	1	1	1	1	1	1	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1
	XIV. (Kondás)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1