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Distribution and Habitat Conditions of Habitat Points of the Eurasian Otter *Lutra lutra* in the Hangang River Water System, South Korea

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Abstract: Researchers conducted this study to clarify the distribution and habitat conditions of the Eurasian otter *Lutra lutra* in the Hangang water system, South Korea. Researchers evaluated a total 358 habitat sites widely distributed in the Hangang river water system. The altitudinal distribution ranges were similar in the Bukhangang and Namhangang areas. The width of river in habitat points ranged from 4-1,017 m. The mean water velocity was 0.32±0.15 m sec^{-1}. Habitat variables such as site condition, river width, bottom status, bankside vegetation, land use type, grass height, vegetation cover, artificial structures, water use and pollutants were significantly different among areas except for forest type and shrub height. Furthermore, land use type, artificial structures, water use and pollutants were disturbance factors. To conserve the Eurasian otter and its habitat, the riparian habitat should be managed and conserved.

Key words: Eurasian otter, habitat, South Korea, spraint, water system, pollutants

INTRODUCTION

Human activities in riparian ecosystems such as dam construction, housing, cultivation and road construction, have increased dramatically over the past 50 years in South Korea. This has led to dramatic changes in riparian habitats, fish populations and the structure of biological communities across the entire water system as well as a reduction in water quality, flow rate and temperature. Furthermore, artificial structures (e.g., dam walls) prevent the natural movement and migration of fish and other species (Alam *et al*., 1995; Collares-Perira *et al*., 2000; Sales-Luis *et al*., 2007).

The population of the Eurasian otter *Lutra lutra* has decreased dramatically in the Palearctic (Macdonald *et al*., 1994). This mammal is now rare or extinct in many Eurasian countries. Several researchers have investigated the habitat and environmental factors that affect the Eurasian otter (Lunnon and Reynolds, 1991; Prenda and Granadio-Lorencio, 1996). Aside from factors such as dense riparian cover and low disturbance, good habitat for Eurasian otters should include foraging areas with abundant food resources (Beja, 1996). The minimum habitat requirements of mammals, however are still not fully understood.

Human disturbance, habitat destruction caused by drainage schemes, an increase in water pollution, drowning in fish traps and traffic accidents are thought to have contributed to the decline in abundance of the Eurasian otter (Macdonald *et al*., 1994; Madsen and Prang, 2001). Although, human activities have been implicated in the decline of this species in South Korea (Han, 1987), the effect of human activities upon the distribution and habitat of otters are still largely unknown. The Eurasian otters are very shy and difficult to observe directly in their natural habitat (Jefferies, 1987). Otters are inherently difficult to study because as top predators, they are found at relatively low densities even under optimal conditions and they have a semi-aquatic life-style (Robitaille and Laurence, 2002). For these reasons, the numbers and distribution of spraints are often used to assess otter population status, activity and habitat preference (Kruuk and Conroy, 1987), although many researchers have urged that this technique be used with caution when trying to assess abundance and habitat use (Jefferies, 1986; Mason and Macdonald, 1987; Prigioni *et al*., 2006).

The Eurasian otter is listed as No. 330 in natural monument and endangered species in South Korea. To manage and conserve the Eurasian otters, it is critical to understand the habitat components that are important for this mammal. The purpose in this study was to examine the distribution and relative influence of habitat conditions on the Eurasian otter in the Hangang river water system, South Korea.

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MATERIALS AND METHODS

Researchers conducted this study along the Hangang river water system (37°21'N, 128°00'E), South Korea (Fig. 1). The size of the Hangang river water system is 25, 954 km^2 and its total length is 494 km (KWRC, 2002). The Hangang river water system is 27% of the size of South Korea. It is a very important water resource for Seoul, the capital of South Korea. Due to urbanization and civilization of Seoul and its vicinity, the pressure to further develop and exploit the Hangang River water system is increasing (SMG, 2002). The Hangang water system can be divided into the Bukhangang and Namhangang areas. Researchers investigated sites in Gyeonggi, Gangwon and North Chungcheong provinces.

Researchers conducted field surveys from April 2009 to October 2011. Only spraints or footprints were accepted as evidence of Eurasian otter (Madsen and Prang, 2001). Field signs of the Eurasian otter were surveyed and collected by boat and on foot in the

Fig. 1: Distribution of habitat points (•) of the Eurasian otter *Lutra lutra* in the Bukhangang and Namhangang regions of the Hangang river water system, South Korea

Table 1: Description of habitat variables of the Eurasian otter *Lutra lutra* in this study (Madsen and Prang, 2001)

Variables	Description
Altitude	masl
River width	m
Water velocity	m sec^{-1}
Site conditions	River, confluence, reservoir and dam
River depth	m
Bottom status	Sand, gravel, bedrock and rock
Bankside vegetation	Herbs, shrubs, trees and none
Land use type	Uncultivated, cultivated, fallow, residential
Forest type	Coniferous, deciduous, mixed and none
Grass height	30-60, 60-90, 90-120 and >120 cm
Shrub height	1.0-1.5, 1.5-2.0, >2.0 m, absent
Land cover	1-33%, 34-66%, 67-100%
Artificial structures	Bank revetment, sluice gates under bridge, pier, houses and none
Water use	Agricultural, watersports, fishing and conservational
Pollutants	Non polluted, farming, living and industrial

Bukhangang and Namhangang areas of the Hangang river water system. If spraints or footprints of the Eurasian otter were observed, researchers recorded that site as a habitat point using a Global Positioning System (GPS) unit.

Data for 15 variables were collected to determine the habitat conditions (Table 1). For all habitat points and randomly selected non-observed points (control), researchers created a quadrat (100×100 m). Within this quadrat, researchers surveyed physical features (site conditions, river depth, bottom status and bankside vegetation), status of the adjacent area (land use type, forest type, grass height, shrub height and vegetation cover) and disturbance factors (artificial structures, water use and pollutants) during August and September, 2011. The variables chosen are primarily related to the nature of the water course, cover and levels of human disturbance.

Researchers performed frequency analysis of the habitat variables to clarify the habitat preferences of the Eurasian otter in the Hangang river water system. The data were analyzed using the t-test, Analysis of Variance (ANOVA) and Pearson χ^2-test. The Dunnett T3 test was used in post-hoc comparisons of mean values. The p-values are reported.

RESULTS

Researchers recorded a total 358 habitat points for the Eurasian otter (130 sites in Bukhangang and 228 sites in Namhangang) in the Hangang river water system, South Korea during the study period. The habitat points of the Eurasian otter were widely and evenly distributed in the Hangang river water system (Fig. 1).

The altitudinal distributions of the habitat points ranged from 31-678 masl. The altitudinal distribution ranges were similar in the Bukhangang and Namhangang areas. The mean altitude was 267.04±12.37 m (mean±SE) in Bukhangang and 256.79±10.91 m in Namhangang. There was no significant difference in the mean altitude of habitat points between Bukhangang and Namhangang (t-test, t = 0.62, p = 0.54) (Table 2).

Table 2: Frequency of habitat points of the Eurasian otter *Lutra lutra* according to altitude (masl) in Bukhangang, Namhangang and control areas of the Hangang river water system, South Korea

Altitude (m)	Bukhangang (n = 130)	Namhangang (n = 228)	Control (n = 71)
0-100	9	32	45
101-200	42	74	25
201-300	30	45	1
301-400	26	30	-
401-500	12	23	-
501-600	9	15	-
601-700	2	9	-

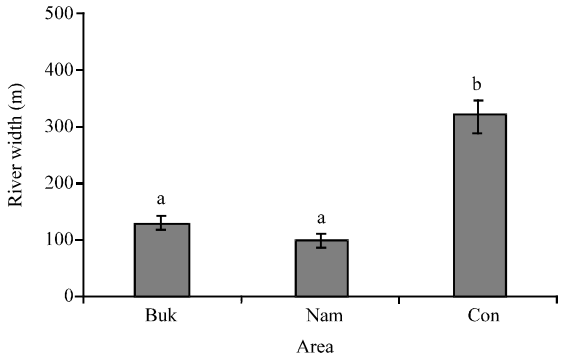

Fig. 2: Difference in river width (m) of the habitat points of Eurasian otter *Lutra lutra* as determined by ANOVA in Bukhangang (Buk), Namhangang (Nam) and Control areas (Con) of the Hangang River water system, South Korea. Different letters indicate significant differences between the mean values ($p<0.05$)

The width of river ranged from 4-1,017 masl. In Bukhangang, river ranged in width from 5-740 m with a mean width of 124.86±14.56 m whereas in Namhangang, the river ranged in width from 4-1,017 m with a mean width of 99.65±9.37 m. In the control areas, the river ranged in width from 5-845 m with a mean width of 320.14±25.42 m. The mean of river widths were significantly different among areas (ANOVA, F = 50.85, $p<0.01$). When Bukhangang and Namhangang were grouped into one group and compared with the control, the mean river width was significantly different between this group and the control (Dunnett T3 test, $p<0.01$) (Fig. 2).

Water velocity in the habitat points ranged from 0.0-1.7 m sec^{-1} with a mean of 0.32±0.15 m sec^{-1}. Water velocities were significantly different among areas (F = 24.76, $p<0.01$). The mean water velocity of control sites was different from that of habitat points in

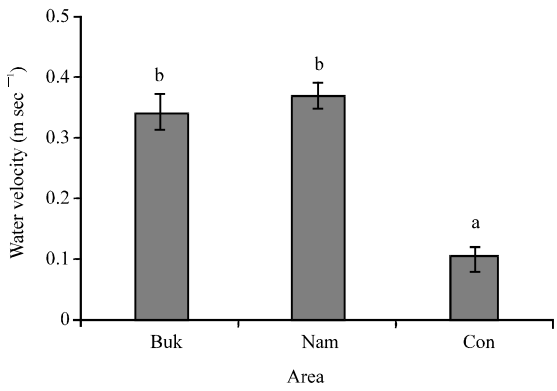

Fig. 3: Difference in water velocity (m sec^{-1}) of habitat points of Eurasian otter *Lutra lutra* as determined by ANOVA in Bukhangang (Buk), Namhangang (Nam) and Control areas (Con) of the Hangang River water system, South Korea. Different letters indicate significant differences between the mean values ($p<0.05$)

Table 3: Pearson χ^2-test result of cross-analysis of habitat conditions for spraint points of the Eurasian otter *Lutra lutra* in the Hangang river water system, South Korea

Variables	df	χ^2	p-value
Site conditions	6	26.20	<0.01
Stream depth	6	60.98	<0.01
Bottom status	6	48.15	<0.01
Bankside vegetation	6	89.27	<0.01
Land use type	6	38.09	<0.01
Forest type	6	10.42	NS
Grass height	6	13.97	<0.05
Shrub height	6	2.70	NS
Land cover	4	16.00	<0.01
Artificial structures	8	100.39	<0.01
Water use	6	22.93	<0.01
Pollutants	6	58.38	<0.01

NS: Not Significant

Bukhangang and Namhangang, when habitat points in Bukhangang and Namhangang were grouped together ($p<0.01$) (Fig. 3).

Habitat variables such as site conditions, river width, bottom status, bankside vegetation, land use type, grass height, vegetation cover, artificial structures, water use and pollutants were significantly different among areas (Pearson χ^2-test, $\chi^2 = 13.97–100.39$, $p<0.05$). There were no differences in forest type and shrub height among areas (Table 3).

DISCUSSION

The Eurasian otter is a top predator in the aquatic food chain in most wetland ecosystems and its presence has been used to raise the profile of the animal and aid in its conservation (Wolters, 1994; Lanszki *et al*., 2009). Over the last five decades, this species has suffered severe declines in both habitat range and number of individuals but due to its secretive and nocturnal nature, these decreases have gone largely unnoticed (Mason and Macdonald, 1987).

A negative relationship between human disturbance (human population density, crop productivity, etc.) and otter inhabitation has been reported in most European countries (Madson and Macdonald, 1986). The European otter has been widely recorded in the Hangang river water system. However, factors that could prevent habitation by the Eurasian otter such as land use type, artificial structures, water use and pollutants have increased in intensity in South Korea in recent years.

Water systems provide important habitats for riparian wildlife such as the Eurasian otter. The main food items of the Eurasian otter are fishes and its habitat use is related with water, available shelters and food resources (Barbosa *et al*., 2001). To ensure conservation of the otters, efforts should be made to maintaine to high riparian cover and decrease obstacles in the water system (Medina, 1998).

Spraint abundance can be used as a broad indicator of the status of a population, provided sample sizes are large enough for statistical comparison. A high abundance of spraints indicates high revisitation rates (Medina-Vogel *et al*., 2003). researchers were able to assess the distribution and habitat conditions of the Eurasian otter by examining the characteristics of spraints and recording the sites at which they were collected as habitat points.

Although, researchers did not replicate this study in other water systems, the results do suggest that habitat conditions are the key determinants of the survival of Eurasian otter populations. Further studies are needed in similar water systems but the results can be used to aid effort to conserve this mammal and inform water management policies.

CONCLUSION

Most studies on otters have been conducted at relatively small scales and independently in space and time, often leading to the use of habitat variables too specific for large-scale conservation applications. The results underscore the need to study the Eurasian otter on a broader scale. A standardized and augmented index of land use would very useful for future broad-scale applications.

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