Hystrix, (n.s.) *7* (1-2) (1995): 269-278 Proc. II It. Symp. on Carnivores

BEHAVIOURAL ECOLOGY OF CAPTIVE OTTERS *LUTRA LUTRA* IN THE BREEDING CENTRE OF THE NATURAL PARK OF TICINO VALLEY (PIEMONTE REGION, NORTHERN ITALY)

RENATO FUMAGALLI, CLAUDIO PRIGIONI & CATERINA CARUGATI

Dipartimento di Biologia Animale, Università di Pavia, Piazza Botta 9, 27100 Pavia, Italy

ABSTRACT – The study was conducted on a pair of otters (*Lutra lutra*) housed in an enclosure of 1.64 ha, located within a wet wood in the Natural Park of the Ticino Valley (northern Italy, Piemonte region). This enclosure contained two ponds (0.2 and 0.45 ha) with fairly good cover vegetation, where a fish biomass of 201.5 kg/ha, represented by 14 fish species, was assessed by electrofishing. Though the food supply for otter was fairly good, the animals were daily fed with 1.5 kg of chicks. meat or rainbow trout (*Salmo gairdneri*). In order to evaluate the habitat selection of otters, the enclosure was divided into 15 environmental units (EU). Hunting, swimming and playing (exclusively in pair) were the main behavioural activities and were preferentially performed close to the ponds' bank, where a thick cover occurred. Otters selected patches for foraging whcrc fish was concentrated and particularly vulnerable to predation. The hunting impact in a given EU (defined as ratio between the number of prey caught in the EU and the total number of prey) was correlated with the hunting time spent in the same EU. Habitat use evaluated by direct observations differed from that determined by considering the marking level (number of spraints and anal secretions). The consumption of the different fish species did not seem to be determined by their relative abundance. *Perca fluviatilis* was particularly selected.

Key words: *Lutra lutra,* Captivity, Behaviour, Habitat use, Feeding selection.

RIASSUNTO – *Ecologia comportamentale della lontra* Lutra lutra *nel centro di studio del Parco Naturale della Valle del Ticino (Regione Piemonte)* – Lo studio è stato condotto su una coppia di lontra (*Lutra lutra)* tenuta in un'ampio rccinto (1.64 ha), situato nel Parco Naturalc della Vallc del Ticino (Regione Piemonte, Provincia di Novara). L'area cintata è ritagliata all'interno di un bosco planiziale c comprcndc 2 bacini idrici (0,2 e 0,4 ha) bordati da discreta copertura vegetale. In tali bacini è stata valutata, mediante elettrostorditore, una biomassa di pesce di 201,5 kg/ha, costituita da 14 specie ittiche. Nonostantc la presenza di qucsta risorsa alimentare, le lontre erano alimentate giornalmente con una dose di circa 1,5 kg di pulcini, carne o trote (*Salmo gairdneri*). AI fine di valutare la selezione di habitat dellc lontrc, l'arca del recinto è stata suddivisa in 15 unità ambientali (UA). La caccia, il nuoto e il gioco (essenzialmentc in coppia) crano lc principali attività comportamentali delle lontre ed erano svolte preferenzialmente lungo tratti di riva copcrti da fitta vegetazione. Le lontre selezionavano ristrette zone per la caccia, in cui il pesce era concentrato e più vulnerabile alla predazione. L'impatto della caccia in una determinata UA (misurato come rapporto tra le prede catturate nell' UA e il numero delle prede totali) era correlato al tempo speso per la caccia nella stessa UA. L'uso dell'habitat valutato attraverso le osservazioni dirette differiva da quello rilevato considerando il numero di segni di presenza (feci e secrezioni anali). Il consumo delle diverse specie ittiche non sembrava essere determinato dalla loro abbondanza rclativa. *Per-cn fluviatilis* era la specie più selezionata.

Parole chiave: *Lutra lutra,* Cattività, Comportamento, Uso dell'habitat, Preferenze alimentari.

INTRODUCTION

During this century the Italian population of otter (*Lutra lutra*) is dramatically decreased both in number and range; this has been particularly evident in the last decades, mainly in northern, where the species disappeared, and in central Italy (Fumagalli & Prigioni, 1993).

In order to improve the conservation of the otter, in 1988 the Natural Park of Ticino Valley (Piemonte region, northern Italy) started an Otter Project. The main purpose was to increase the knowledge on behavioural ecology of this mustelid, and to study the feasibility of its reintroduction in the Valley of Ticino river (Prigioni in this volume).

The present study has been conducted on a pair of captive otters, housed in a wide enclosure, located in the north of Ticino valley (Piemonte region, Novara province). This enclosure was suitable for studying otters with a minimum interference by man.

Some aspects of the behaviour, habitat use and feeding ecology of the otter are reported here.

STUDY AREA

The otter enclosure was 1.64 ha in size and surrounded by a double wire netting fence. The internal net was 1.80 m in height and buried for further 0.6 m. A metallic folded sheet of 0.6 m at the net top and some electrified wires at about 0.8 m from the ground were used to prevent otters from climbing over the fence. The external net (1.80 m in height) was not buried and was 5 m far from the internal one; it served to protect animals from disturbance.

Two connected ponds occupied about the 40% of the enclosure: one was 0.2 ha in size (depth 0.5-2.7 m) with a prevailing bottom of pebbles or gravel, the other 0.45 ha (depth 0.3-2.5 m) with a prevailing bottom of slime. In the larger pond a submerged pile of wood occurred. A short stretch of drain, connecting the ponds and a meander of the Ticino river, was included inside the enclosure. Ponds' banksides were fairly covered with shrubs (*Rubus* spp. and *Salix* spp.) and trees (*Quercus robur, Alnus glutinosa, Populus* spp. and *Robinia pseudoacacia*); about 40 m of bank were occupied by *Phragmites australis* and *Carex* sp.. Two pile of wood were located close to the banks. Inside the enclosure a natural development of the vegetation was maintained. The artificial structures were two sleeping-boxes for otters, a pen of 54 m^2 for handling animals (e. g. sanitary control) and two observation towers.

METHODS

The study was conducted from April 1989 to March 1991. A first pair of otters (female, 2 years and 5 months old from the Norfolk Wildlife Park Trust, Witchingham; male, 1 year and 4 months old from the Zurich Zoo) was released in the enclosure on 4 April 1989. As the male was found dead in September 1989, the female remained on her own until March 1990 when a second male (3 years and 7 months old from the Norfolk Wildlife Park Trust) was released.

Before releasing the otters in the enclosure, 14 fish species were recorded and their abundance was estimated by electrofishing. A fish-biomass of 201.5 kg/ha was found and the main species were *Anguilla anguilla* (33.6% of the biomass), *Cyprinus carpio* (24.9%), *Esox lucius* (15.5%) and *Scardinius erythrophthalmus* (12.9%). In March 1990 a fish-restocking of 150 kg was carried out with *A. anguilla, C. carpio, Tinca tinca* and *Rutilus erythrophthalmus*.

Inside the enclosure mammals were represented by *Oryctolagus cuniculus* (a density of 6.1 active burrows/ha was estimated), *Apodemus* sp., *Crocidura* sp., *Arvicola terrestris, Talpa* sp. and *Myoxus glis*. Ponds were regularly used as wintering sites by *Anas platyrhynchos* (20-30 individuals) and *Gallinula chloropus* (10-20 individuals). Reptiles were represented by *Natrix natrix*, amphibians by frogs (*Rana* sp.). For molluscs, *Viviparus* sp. and *Unio* sp., a density of 1.5 individuals/m^2 was assessed from subaqucous photographs.

Though the food supply for otters was fairly good, the animals were daily fed with 1.5 kg of chicks, meat or rainbow trout (*Salmo gairdneri*). Trout were not present in the ponds.

BEHAVIOURAL ACTIVITIES AND HABITAT USE

The ponds' banksides were monitored and both the structure and composition of the vegetation were recorded. Dives were done by exploring the bottom and slides were taken. On the basis of these recordings, the ponds and their banks were subdivided into 15 "Environmental Units" (EU) (Tab. 1).

Tab. 1 – Description of the environmental units (EU)

EU	DESCRIPTION
1	LARGE POND, SLIMY DEEP BOTTOM
2	LARGE POND, PEBBLY-SLIMY DEEP BOTTOM
3	LARGE POND, PEBBLY DEEP BOTTOM
4	LARGE POND, SLIMY SHALLOW
5	CANAL CONNECTING THE PONDS AND DRAIN
6	PILE OF WOOD DIPPED IN THE WATER
7	SMALL POND, PEBBLY-SLIMY DEEP BOTTOM
8	SMALL POND, PEBBLY DEEP BOTTOM
9	BORDERS WITH SHRUBS
10	BORDERS WITH SEDGE
11	BORDERS WITH SHRUBS AND TREES
12	BORDERS WITH TREES' BRANCHES PROTRUDING ON THE WATER
13	PILE OF WOOD ON THE BANK
14	BORDERS WITH GRASS
15	BORDERS WITH REEDS

The EU "Borders" were defined as the space of ponds' boundaries included between 0.5 m in the water and 0.5 m outside the water. The units were chosen in accordance to the hiding opportunities and food availability for the otters: e.g., borders with shrubs offered good shelter for animals and slimy bottom was important as resting sites for eels or carps, usually preyed on by otters. The area of each EU was measured on a 1:200 scale map by using an electronic graphic tablet.

The habitat use was assessed by both direct observations and marking level recorded in each EU.

Direct observations were made twice a week from the two towers and were distributed throughout the 24 hrs; a light intensilicd binocular (Wild Big 3x) was used at night. Each recording session lasted 3-5 hrs. The activity of the otters was divided into behavioural categories (Tab. 2) and timed in seconds.

Tab. 2 – Behavioural categorics.

1	SWIMMING (Sw)
2	HUNTING (Hu)
3	PLAYING (Pl)
4	EATING (Ea)
5	WALKING OR RUNNING (Wa)
6	CARRYING FOOD OR MATERIAL TO THE HOLT (Cf)
7	RESTING (Re)
8	MARKING AND SMELLING **(Ma)**
9	GROOMING AND ROLLING (Gr)
10	AGGRESSIVENESS AGAINST MAN (Ag)

In order to evaluate the habitat use by marking level, the number of otter signs (spraints and anal secretions) were weekly recorded. Signs found on the banks were shared out among the EU previously defined (Tab. 1). In a first step, all the signs were attributed to the EU of the ponds (from 1 to 8), in a second step to the EU of the shore-side (from 9 to 15).

Habitat use was assessed by the Preference Index (PI) defined by Robel et al. (1970):

$$PI = \frac{PU_i}{PA_i}$$

where PU_i is the proportion of use for EU_i calculated as time spent or number of signs recorded in the same EU and PA_i is the proportion of availability of each EU considering their area. When IP < 1 the EU is avoided, when IP > 1 the EU is selected. Nevertheless, we considered that an EU was selected when IP differed largely from 1. To evaluate the hunting impact, PU_i was the ratio between the number of prey caught in EU_i and the total number of taken prey.

The Pearson correlation coefficient was used to test the relationship between the hunting PI and hunting impact PI recorded for each EU, and between the habitat PI evaluated by direct observations and by marking level.

FEEDING SELECTION

Feeding habits were studied by the analysis of 4067 spraints; food remains were identified using taxonomic keys (Day, 1966; Webb, 1976; Watson, 1978; Debrot et al., 1982; Camby et al., 1984) and personal collections. Remains of the food offered to otters were separated from those related to prey taken in the ponds. Data collected were expressed as percentage of estimated weight of each prey intake on the total estimated weight. To evaluate the average weight of fishes we used data obtained by electrofishing sampling and restocking; for the other prey literature data were considered.

Fish selection was assessed by comparing fish intake biomass and available fish biomass.

RESULTS

BEHAVIOUR AND HABITAT PREFERENCE

Hunting was the main activity and occupied more than 50% of the total time spent by the female and the male, either individually (57.5% and 52.5% respectively) or in pair (52.9%); swimming was the second activity in order of importance (29.6% for the female, 30.1% for the male and 14.8% for the pair) (Fig. 1). Playing was performed only in pair (26.6%) and occurred mainly during the courtship and mating period (June-August 1990). The other behavioural activities were scarcely represented.

Direct observations showed that otters selected waters close to the banks, while the open waters were scarcely used. Banks covered by trees with protruding branches on the water (EU 12) were largely preferred (IP = 13.6) (Fig. 2). This habitat was also particularly selected for hunting, swimming and playing (Figg. 3-5). The hunting PI and the hunting impact PI recorded in each EU were highly correlated ($r = 0.71$, $P = 0.003$, $N = 15$) (Fig. 3).

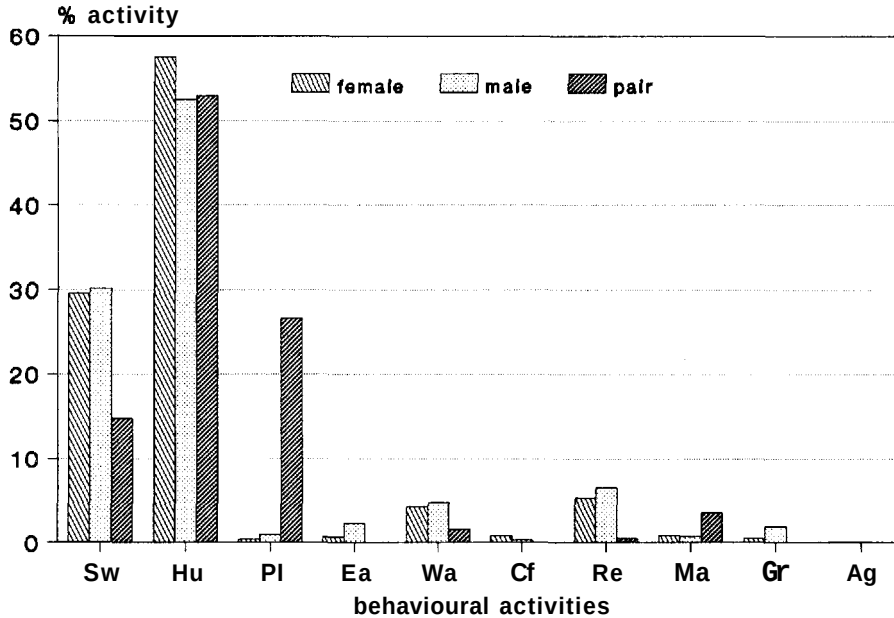

Fig. 1 – Proportion of time spent by single otter or pair in various behavioural activities (see Tab. 2 in the text for legend of the activities).

Considering the marking data related to each EU, otters selected the small pond, particularly the habitats characterized by plebby and slimy deep bottom (EU 7 and EU 8) (Fig. 6). There was no correlation between the habitat use assessed by direct observations and by marking level

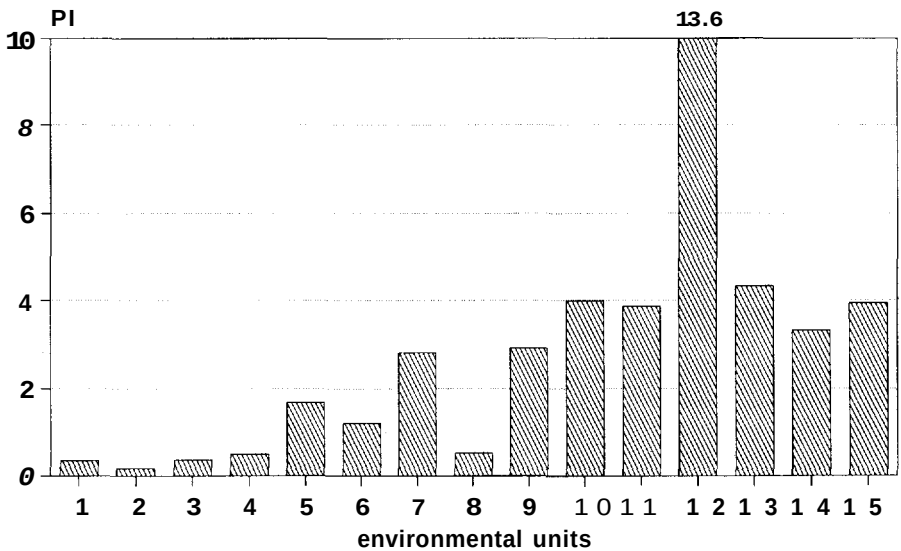

Fig. 2 – Preference Index (PI) for each environmental units (EU) calculated on the basis of the time spent in the overall activity (see Tab. 1 in the text for legend of EU; for EU 12 the IP value out the range is indicated over the bar).

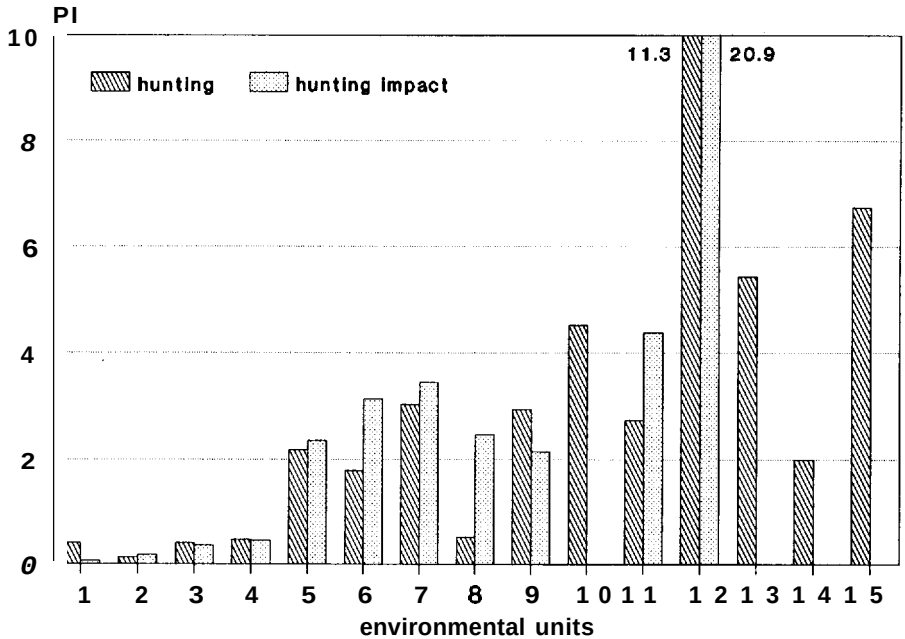

Fig. 3 – Hunting and hunting impact Preference index **(PI)** recorded in each environmental units **(EU)** (see Tab. I in the text for legend of EU; for **EU** 12 the IP values out the range are indicated close to the bars).

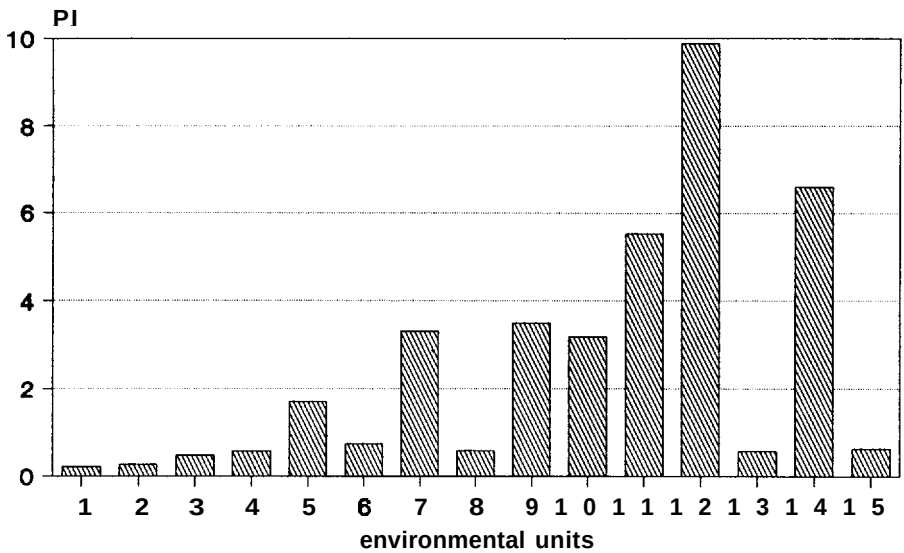

Fig. **4** – Swimming Preference index (PI) recorded in each environmental units **(EU)** (see Tab. I in the text for legend of EU).

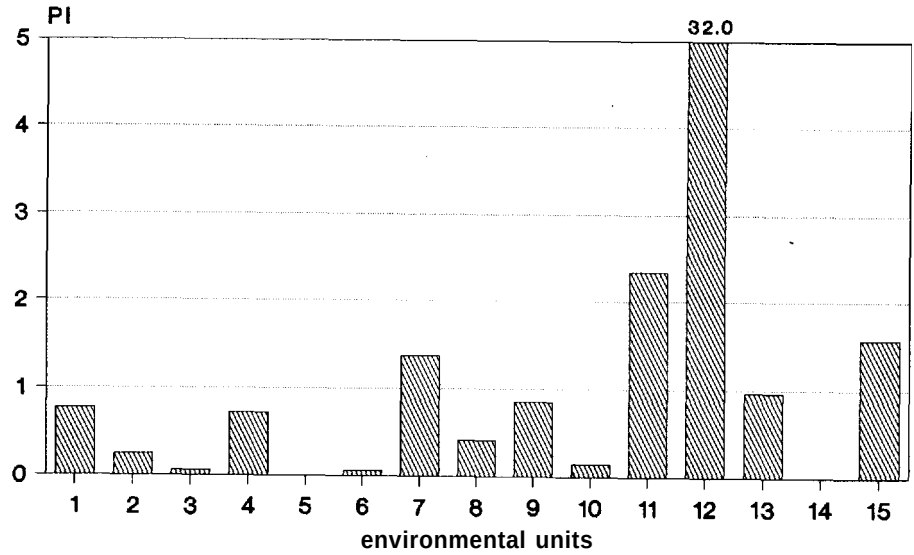

Fig. 5 – Playing Preference index (PI) recorded in each environmental units (EU) (see Tab. 1 in the text for legend of EU; for EU 12 the IP value out the range is indicated over the bar).

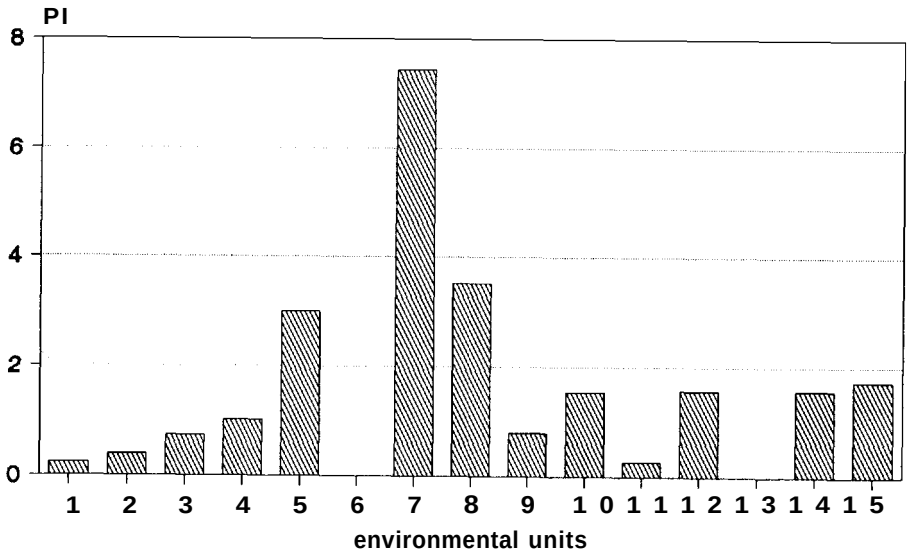

Fig. 6 – Marking Preference Index **(PI)** recorded in each environmental units (EU) (see Tab. 1 in the text for legend of EU).

DIET AND FOOD SELECTION

The fish was the staple in the diet and was largely represented by Percidae (*Perca fluviatilis*) and to a lesser extent by Cyprinidae, mainly *T. tinca* and *R. erythrophtalmus*, **A.** *anguilla* and *E. lucius* (Tab. 3).

In relation to the availability of different fish species, otters seemed to prefer *T. tinca*, *Lepomis gibbosus* and particularly *P. fluviatilis* (Fig. *7)*.

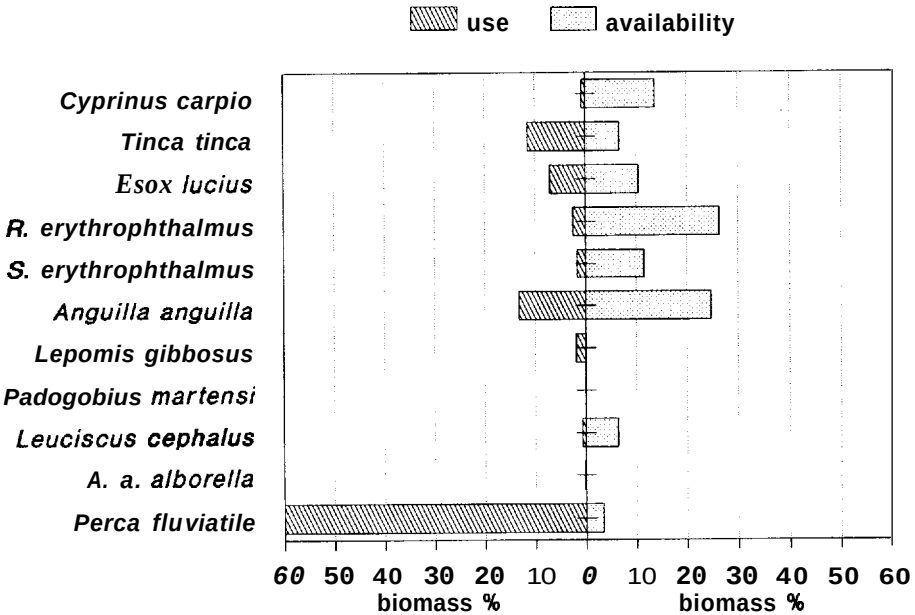

Fig. 7 – Relationship between use and availability of the fish species consumed by otters (R. = *Rutilus*; S. = *Scardinius*; **A.** a. = *Alburnus alborella)*

Tab. 3 – Main food categories consumed by otters

FOOD CATEGORIES	% BIOMASS
Molluscs	0.7
Crustaceans	0.2
Insects	0.2
Fishes	96.3
Anguilla anguilla	12.7
Esox lucius	6.8
Cyprinidae	18.5
Centrarchidae	0.2
Percidae	58.1
Other fishes	0.02
Amphibians	0.06
Reptiles	0.5
Birds	0.7
Mammals	1.3

DISCUSSION

Otters were very active and spent most of the time hunting and swimming. These activities were preferentially performed in sheltered water habitats (along the ponds' bank, EU 9-15) rather than in open water habitats (EU 1-8). Otters caught most of their fish prey close to the bank, exploring mainly amongst tree roots, reeds and sedge where fish often seeks cover. Hence they selected very small areas (e.g. EU 12) for foraging, where fish concentrated and was particularly vulnerable to otter predation. Since there was an evident positive correlation between the hunting time spent by otters in a given EU and the hunting impact in the same EU, it seems that the use of restricted areas for foraging is linked to a high probability to catch prey. This foraging pattern, called "patch fishing", is the most common one in the wild (Kruuk & Moorhouse, 1990; Kruuk et al., 1990).

The importance of riparian vegetation to the otters has been emphasized in several field studies (e.g. Mason and Macdonald, 1986). In our case the dense cover constituted by trees with protruding branches on the water was selected by otters for playing activity, especially during the courtship and mating. In this period playing is a prominent activity in the breeding behaviour (Chanin, 1985; Harper & Jenkins, 1981) and otters need very peaceable sites.

Field spraint surveys have been used to assess otter habitat selection (Mason and Macdonald, 1987; Jefferies, 1986). In our study there was difference in habitat use evaluated by direct observations and by marking level. So much caution has to be taken in the use of spraint density as an indicator of the habitat selection of otters. On the other hand spraints seemed to be related to fish availability. Great amount of spraints, for example, was found close to the reed thicket, where fish resources were clamped.

The selection of fish prey like *P. fluviatilis* and *L. gibbosus* could be due to an under-estimation of their biomass by electrofishing. Nevertheless, these species had generally a gregarious behaviour and seemed to be particularly vulnerable whilst inactive in cover, especially between reeds, sedge or pile of wood.

In this study several aspects of behavioural ecology of the otter did not differ from those recorded in the wild. This means that the environmental conditions of the enclosure satisfy main ecological requirements of otters. Hence the enclosure can be considered suitable as a training for the development of a natural behaviour of the animals.

ACKNOWLEDGEMENT — We would like to thank the Natural Park of the Ticino Valley (Piemonte Region) for the logistic assistance and the Akzo Chemicals for financial support.

REFERENCES

CAMBY, A., LE GALL, O. & C. MAIZERET. 1984. Atlas d'identification des restes alimentaires de la Loutre (premiers éléments). Groupe Loutres, Bulletin dc Liaison, G.E.R.E.A., Université de Bordeaux I, n. 16.

CHANIN. P. 1985. The Natural History of otters. Croom Helm, London & Sydney, 179 pp.

DAY, M.G. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. Journal of Zoology, London, 148: 201-217.

DEBROT, S., FIVAZ, G., MERMOD, C. & J.M. WEBER. 1982. Atlas des poils de mammifères d'Europe. Ed. Institut dc Zoologie, Université Neuchâtel, 208 pp.

FUMAGALLI, R. & C. PRIGIONI. 1993. Evoluzione della distibuzione della Lontra *(Lutm lutra)* in Italia e possibilità di sopravvivenza dei nuclei residui. Suppl. Ric. Biol. Selvaggina, XXI: 197-207.

HARPER, R. & D. JENKINS. 1991. Mating behaviour in the European otter *(Lutm lutra)*. J. Zool., Lond., 19.5:556-558.

JEFFERIES, D.J. 1986. The value of otter *Lutm lutra* surveying using spraints: an analysis of its successes and problems in Britain. J. Otter Trust, 1: 25:32.

KRUUK, H. & **A.** MOORHOUSE. 1990. Seasonal and spatial differences in food selection by otters *Lutra* ***lutra*** in Shetland. J. Zool., London, 221: 621-637.

KRUUK, H., WANSINK, D. & **A.** MOORHOUSE. 1990. Feeding patches and diving success of otters *(Lutra lutra* L.) in Shetland. Oikos, 57: 68-72.

MASON, C.F. & S.M. MACDONALD. 1986. Otters: ecology and conservation. Cambridge University Press, Cambridge, 236 pp.

MASON, C.F. & S.M. MACDONALD. 1987. The use of spraints for surveying otter *Lutra lutra* populations: an evaluation. Biol. Conserv., 41: 167-177.

PRIGIONI, C. Guidelines for the feasibility study of reintroduction of the otter *Lutra lutra* in Italy: the Project of the Ticino Valley (Northern Italy) (in this volume).

ROBEL, R.J., BRIGGS, J.H., CEBULA, J.J., SILVY, N.J., VIERS, C.E. & P.G. WATT. 1970. Greater prairie chicken ranges, movcmcnts, and habitat usage in Kansas. J. Wildl. Manage., 34: 286-306.

WATSON, H. 1978. Coastal otters *(Lutmlutra* L.) in Shetland. Vincent Wildlife Trust, London.

WEBB, J.B. 1976. Otter spraint analysis. The Mammal Society, Reading.