

## GUIDELINES FOR THE FEASIBILITY STUDY OF REINTRODUCTION OF THE OTTER *LUTRA LUTRA* IN ITALY THE PROJECT OF THE TICINO VALLEY (NORTH-WESTERN ITALY)

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**ABSTRACT** – This study was conducted in the Ticino valley (north-western Italy) taking into account the main factors affecting the survival of the otter (*Lutra lutra*). The concentration of PCBs and DDT in fish tissues did not exceed the critical level proposed by the National Academy of Sciences of USA for fishes preyed on by carnivores. The biological water quality, assessed by Extended Biotic Index, was fairly good for the entire course of the Ticino river. The availability of fish resources seemed to be suitable to satisfy the feeding requirements of otters. The biological water quality and the food supply were better than those recorded in rivers of central-southern Italy hosting the last strongholds of otters. The habitat suitability of the Ticino valley was assessed by an index calculated considering the availability of different type of habitats (suitable and unsuitable to the otter) and their importance for the species survival. The valley was divided into 114 territorial units of 1 km<sup>2</sup> each where 26 different habitats were measured. The 16.7% of the study area showed a moderate/very good suitability and the 38.1% a low suitability. About 80 km of the Ticino river were continuously occupied by suitable habitats for otters. It appears that there are no particular contra-indications to advising for the reintroduction of the otter into the Ticino valley. Nevertheless, it would be necessary to combine this operation with a global policy of correct management and restoring of the riverine habitats.

**Key words:** Otter, Pollution, Water quality, Habitat suitability, Reintroduction.

**RIASSUNTO** – *Linee guida per lo studio di fattibilità della reintroduzione della lontra (Lutra lutra) in Italia: il progetto della Valle del Ticino (Italia nord-occidentale)* – Lo studio è stato condotto nella Valle del Ticino (Italia nord-occidentale) prendendo in esame i principali fattori che influenzano la sopravvivenza della lontra (*Lutra lutra*). Le concentrazioni di PCB e DDT nei tessuti dei pesci non eccedono i limiti di accettabilità proposti dalla Accademia Nazionale delle Scienze degli Stati Uniti per i pesci predati da carnivori. La qualità biologica delle acque, valutata mediante l'indice biotico E.B.I. (Extended Biotic Index), è risultata abbastanza buona per l'intero corso del Ticino. Anche la disponibilità delle risorse ittiche sembra essere idonea a soddisfare le esigenze alimentari della lontra. I dati relativi alla qualità biologica delle acque e alla disponibilità di risorse trofiche evidenziano una situazione più favorevole di quella riscontrata in fiumi dell'Italia centro-meridionale dove la specie è stabilmente presente. L'idoneità ambientale per la lontra della valle del Ticino è stata valutata attraverso la definizione di un indice che tiene conto della disponibilità dei diversi tipi di ambienti, favorevoli e sfavorevoli alla specie, e della loro relativa importanza per la sopravvivenza del mustelide. La valle è stata suddivisa in 114 unità territoriali di 1 km<sup>2</sup> ciascuna, in cui sono state misurate 26 differenti categorie ambientali. Il 16,7% e il 38,1% del territorio mostrano rispettivamente valori di idoneità medio-alti e bassi. Circa 80 km del corso del Ticino sono interessati da una buona continuità di ambienti favorevoli alla specie. Lo studio di fattibilità della reintroduzione della lontra evidenzia che non

esistono controindicazioni tali da sconsigliare l'intervento, che, comunque, dovrebbe essere supportato da una politica di corretta gestione e riqualificazione degli ambienti fluviali.

Parole chiave: Lontra, Inquinamento, Qualità dell'acqua, Idoneità ambientale, Reintroduzione.

## INTRODUCTION

The otter *Lutra lutra* is one of the Italian rarest mammals. Its range is severely restricted and covers about 7700 km<sup>2</sup> according to a 10x10 km grid of the cartographic maps (1:25000 scale) of the Italian Army Geography Institute. Throughout the period 1984-93 the species was recorded in 42 water bodies, mainly rivers and streams located in central and southern Italy. About 900 km of watercourses held otters and a mean density of 1.4 individuals/10 km of banksides was estimated in some rivers (Prigioni & Fumagalli, in press). Taking into account these data, the total Italian population could reach as much as 125 individuals. According to Fumagalli & Prigioni (1993) the population is fragmented into 5 main groups; the greatest one occurred in southern Italy; and an extinction time of 43-53 years was estimated in relation to the assumption of 40-80% of reproductive females.

Prigioni and Fumagalli (1992) outlined a conservation strategy of the otter in Italy based on intensive management action, in particular habitat restoration, captive breeding and reintroduction. In the last years, the critical situation of the otter stimulated the discussion about its reintroduction, but only some generic proposals were done.

According to Ralls (in press) a program for reintroduction of this mustelid is very complex and requires a feasibility study, a preparation phase, a release phase and a follow up phase. For Italy, the feasibility of reintroduction of the otter in the Ticino Valley is one of the conservation priorities listed in the Action Plan (Macdonald and Mason, 1991). The otter has recently disappeared (1980) from this valley, probably because of the pollution by toxic substances and overhunting. In order to define the habitat quality of the Ticino valley for otters, some preliminary studies were undertaken (Mason et al., 1985; Prigioni, 1986). The present work is a further investigation following these studies and the feasibility of reintroduction is examined considering the main factors affecting the otter survival. In order to define a model for evaluating the habitat suitability for otters, a comparison of the data on the water quality and on the availability of food resources between some Italian rivers holding otters and the Ticino river is reported.

## STUDY AREA

The Italian stretch of the valley of the Ticino river is about 110 km long and 7 km wide in average. It is located in north-western Italy between the Lake Maggiore and the Po river. A large part of this area is protected by two Regional Parks (total surface = 968.9 km<sup>2</sup>) and includes several wetlands. The Ticino river has a meandering course, particularly in the south, and there are several streams, oxbow lakes, canals, reservoirs and fish-ponds. These water bodies together with the Ticino river cover a total surface of 48 km<sup>2</sup> and are about 170 km in length. Most water bodies cross riparian woodlands of oaks (*Quercus robur*), alders (*Alnus glutinosa*), poplars

(*Populus alba* and *P. nigra*), and willows (*Salix* sp. pl.). A detailed description of the vegetation and forest systems is reported by Sartori (1990). Some general characteristics of the Ticino valley are summarized in Tab. 1.

The study area has a temperate climate with a mean annual temperature of about 13°C and an annual range of 23°C. Annual precipitation decreases from north (1200 mm) to south (700 mm). The population density varies from about 100 people km<sup>-2</sup> to over 1000 people km<sup>-2</sup> with the highest concentration in the north.

Gravel extraction is forbidden in the river bed of the Ticino and in its highest alluvial terraces; the extraction activity is localized in some terraces 1-8 km away from the main course of the river.

The Ticino valley is an important Italian wintering site for wildfowl (mainly ducks) (Prigioni & Galeotti, 1989) and regularly hosts 8 heronries with a nesting population of about 3000 pairs each year (Fasola, pers. comm.). Fishes are represented by 45 species, 21 of which are cyprinids (Bernini et al., in press). Angling is widespread and a mean density of 22.5 fishermen per km of river was assessed by surveys carried out in spring-summer 1989 and 1990 (Prigioni, unpublished data); the density increased from north to south, with a peak of 42 fishermen/km in the lower course of the river.

Tab. 1 – Some environmental characteristics of the Ticino valley.

Protected area:	
Park of the Ticino valley (Lombardia Region)	906,4 km <sup>2</sup>
Natural Park of the Ticino valley (Piemonte Region)	62,5 km <sup>2</sup>
Catchment and flows of the Ticino river:	
Catchment basin surface (in Italy)	3,230 km <sup>2</sup>
Drained area from Lake Maggiore to Po river	802 km <sup>2</sup>
Annual average flow	300 m <sup>3</sup> s <sup>-1</sup>
Flow in ordinary flood	900 m <sup>3</sup> s <sup>-1</sup>
Flow in extraordinary flood	> 1,500 m <sup>3</sup> s <sup>-1</sup>
Flow in low	10 m <sup>3</sup> s <sup>-1</sup>
Surface of the water bodies:	
Ticino river	22 km <sup>2</sup>
Natural canals and streams	12 km <sup>2</sup>
Irrigation canals and ditches	5 km <sup>2</sup>
Oxbow lakes	2 km <sup>2</sup>
Reservoirs and fish-ponds	7 km <sup>2</sup>
Forest surface:	
Wet woods	87 km <sup>2</sup>
Dray woods	90 km <sup>2</sup>

## METHODS

This study, started within a wide program on the land-planning of the Ticino valley addressed to the management and conservation of vertebrate species (Prigioni *et al.*, 1989), was conducted from 1983 to 1991 considering the whole area of the two regional parks and a surrounding band of 145 km<sup>2</sup>. The territory was divided into 1114 units of 1 km<sup>2</sup> each where the surface covered by 26 main habitats (Tab. 2) was measured on a 1:7500 scale aerial-photograph taken in June 1986, by using an electronic graphic tablet; for water bodies the shoreline development was also calculated.

Tab. 2 – List of habitats measured in each of the 1114 units of 1 km<sup>2</sup> of the Ticino valley.

1. Dairy farms	14. Pine forests
2. Villages and towns	15. Heath
3. Roads and railway	16. Popular plantations
4. Industrial plants	17. Orchards in prevalence
5. Other plants	18. Meadows and pastures
6. Mixed high forests mainly dominated by <i>Q. robur</i>	19. Cereal crops
7. Mixed high forests mainly dominated by <i>A. glutinosa</i> and <i>Salix</i> spp.	20. Canals and ditches
8. Coppice forests in prevalence	21. Oxbow lakes
9. Shrub forest in prevalence	22. Irrigation's canals
10. Reed thicket	23. Reservoirs
11. Herbaceous vegetation in prevalence	24. Water surface of the river
12. Hedges bordering crops, and canals and ditches	25. Sandy and gravelly ground in the river bed
13. Bare ground	26. Herbaceous and shrub vegetation in the river bed

For each unit an index of habitat suitability (IS) for the otter was defined as follows:

$$IS = \frac{K_1 SH_1 + K_2 SH_2 + \dots + K_n SH_n}{USH_1 + USH_2 + \dots + UH_n}$$

where SH is the surface of suitable habitats (e.g. oxbow lake, reed thicket, high forest dominated by alders and willows), K is a factor that expresses the degree of potential use (as foraging or resting sites) of a certain habitat (K was chosen in the following set: 0.5-1-2-4-8-16) and USH is the surface of unsuitable habitats for the otter (e.g. antropic structures as roads and industrial plant; crops in general, bare ground). For the water bodies, the maximum value of the K factor (16) was attributed to the oxbow lakes because they maintained a high fish biomass (see Results), while the minimum one was assigned to the irrigation's canals. Similarly, mixed high forests dominated by alders, willows and oaks or the reed thicket were more important than pine forests or heath.

The IS value, calculated for each territorial unit, varied from 0 to 197 and was visualized in a schematic map (Fig. 4) according to the following five suitability classes: unsuitable (index value < 1), low (1-50), moderate (51-100), good (101-150) and very good (> 150).

In order to assess the water quality of the Ticino river and its tributaries, we used the data on toxic residues (PCBs and DDT) in fish tissues (Nardi et al., 1993), and the Extended Biotic Index (E.B.I., Ghetti, 1986) recorded from 21 stations distributed (3-8 km one from another) on the entire course of the Ticino river which were regularly sampled in spring from 1983 to 1992 (Bisogni et al., 1992; G. Boffino, pers. comm.). These data were compared with those collected in spring 1988 from 5 rivers of the central and southern Italy holding otter populations (A. Tursi, G. Costantino & A. Matarrese, unpublished data); stretches of each investigated river varied from 26 to 86 km and a total of 29 stations spaced 4-18 km one to another was sampled.

During the spring 1985 and 1986 fish biomass (kg/ha) was estimated by electrofishing in 8 different water bodies (4 oxbow lakes, 3 canals and 2 stretches of river) of the Ticino valley (Prigioni, unpublished data). The data collected were compared with those recorded in spring 1988 from 14 stretches of the Agri and Basento rivers (southern Italy) where viable populations of otters occurred (Prigioni, unpublished data). For both cases electrofishing samplings (an Inverter RD 750 12 Volt was used) were carried out in slow deep water (0.4-1.2 m) by exploring stretches of water bodies of 100-200m in length.

The Mann-Whitney U test was used for comparing the E.B.I. level and fish biomass between the Ticino river and the Italian rivers hosting otter populations.

RESULTS

The biological water quality of the Ticino river was generally fairly good in all of the sampled stations (Fig. 1); only for a station located on the upper course, the E.B.I. value indicated environmental alteration. The E.B.I. for the Ticino river was higher than that recorded in the Italian rivers hosting otter populations (Fig 2, median value 10 vs. 8;  $Z = 5.1$   $P < 0.0001$ ). By contrast, the PCBs and DDT concentrations in fishes of these rivers were lower than those found in the Ticino, except for PCBs level in eels (Fig. 3). However a statistical comparison within the same fish species was not done because the single data collected by Nardi et al. (1993) were not available.

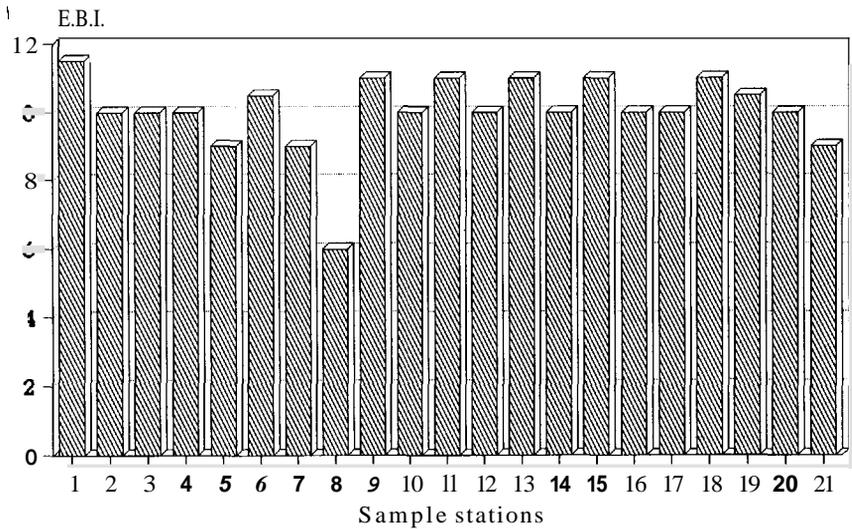


Fig. 1. – E.B.I. median values recorded in 21 sample stations of the Ticino river, distributed from upper to downstream (data recorded from 1983 to 1992).

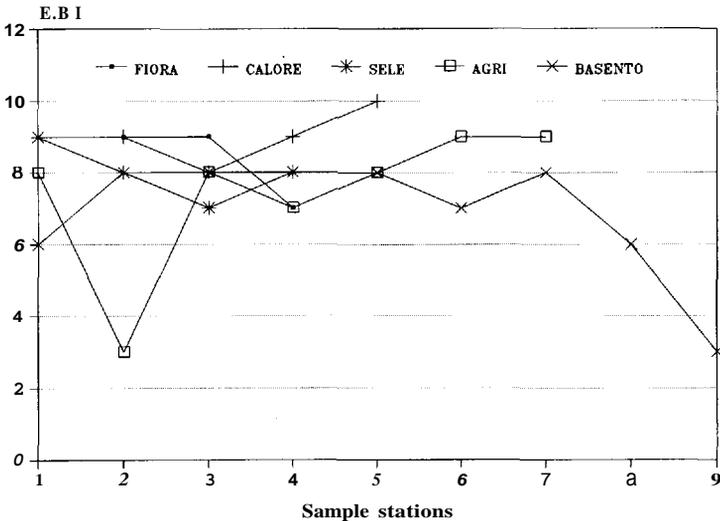


Fig. 2. – E.B.I. values recorded in 5 Italian rivers hosting otter populations (sample stations distributed from upper to downstream).

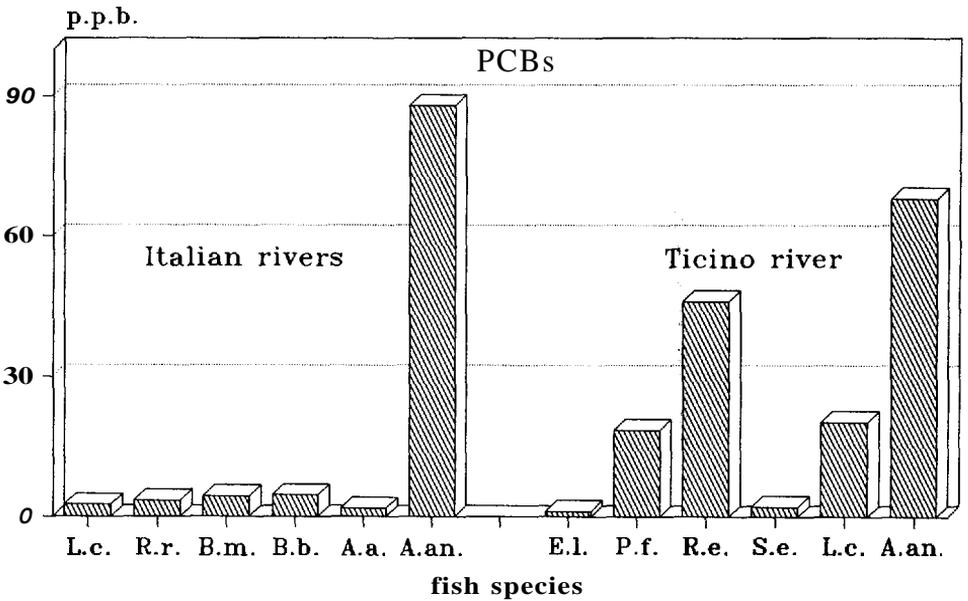
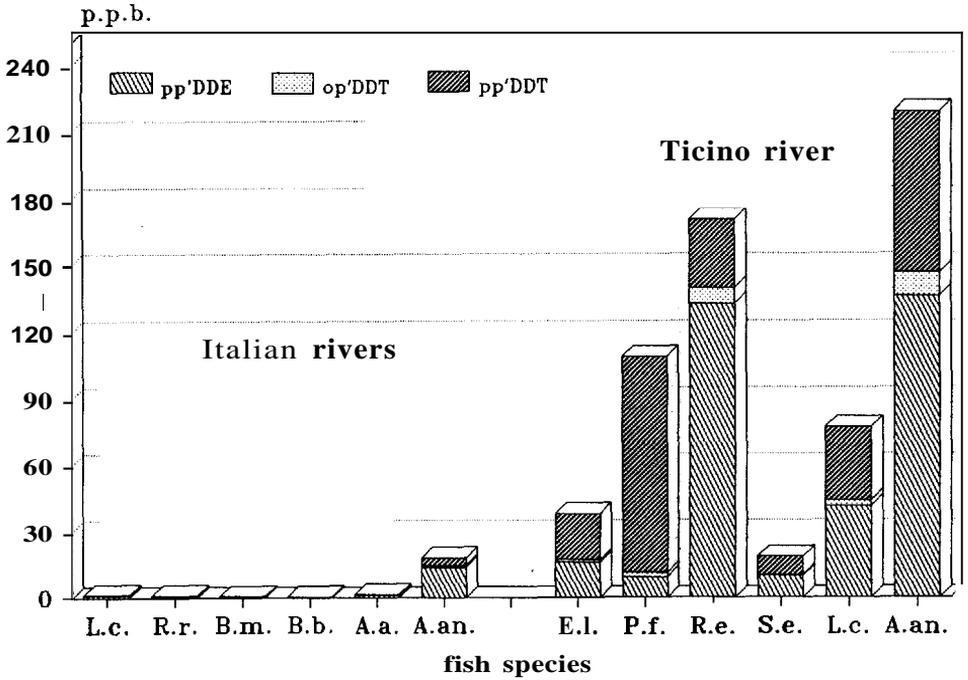


Fig. 3. - Concentration (p.p.b.) of DDT, DDE and PCBs in fish tissues. Data collected in 5 Italian rivers, and in Ticino river and its tributaries. (L.c. = *Leuciscus cephalus*; R.r. = *Rutilus rubilio*; B.m. = *Barbus meridionalis*; B.p. = *Barbus barbatus plebejus*; A.a. = *Alburnus albidus*; A.an. = *Anguilla anguilla*; E.l. = *Esox lucius*; P.f. = *Perca fluviatilis*; R.e. = *Rutilus erythrophthalmus*; S.e. = *Scardinius erythrophthalmus*).

Fish biomass recorded in some water bodies of the Ticino river was mainly represented by cyprinids (*Leuciscus cephalus*, *Rutilus erythrophthalmus* and *Scardinius erythrophthalmus*) and eels (*Anguilla anguilla*). A similar situation was found in Agri and Basento rivers where the most common cyprinids were *L. cephalus*, *Rutilus rubilio* and *Barbus barbus plebejus*. Pooling all the data, the fish biomass estimated for the Ticino river did not differ from that recorded in Agri and Basento rivers (Tab. 3).

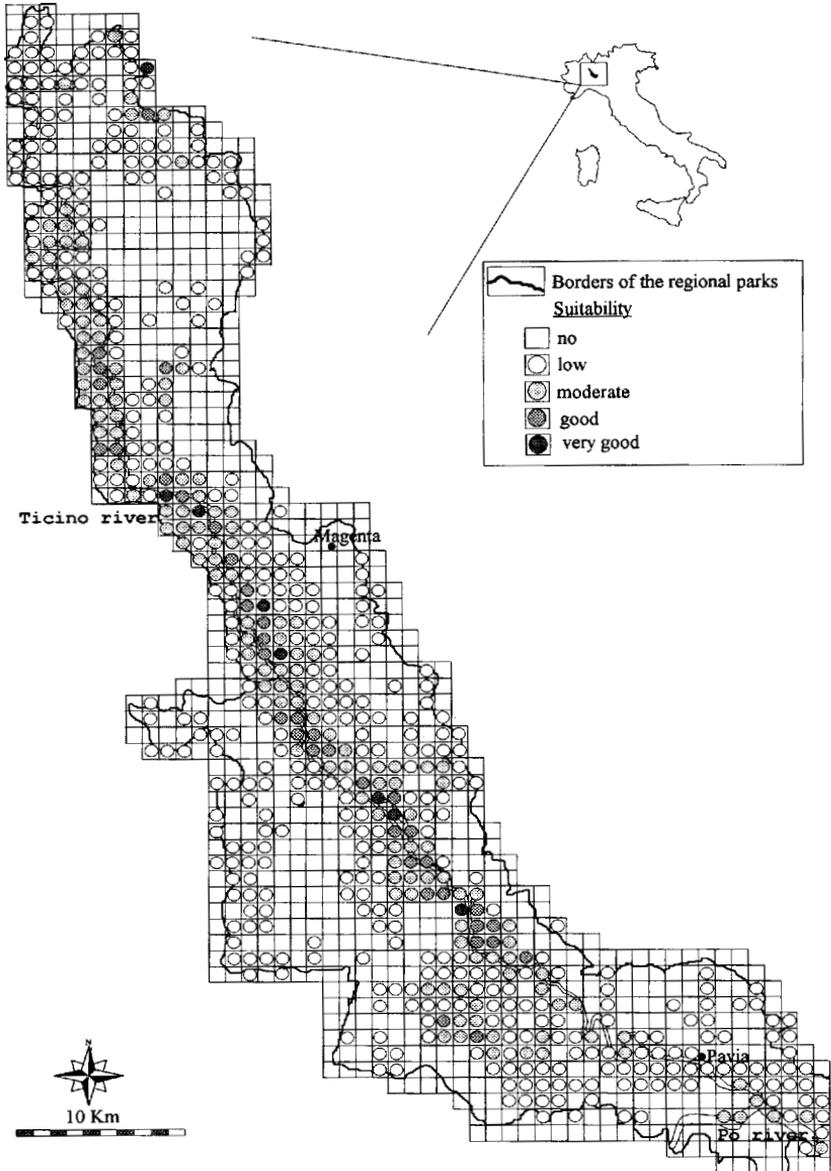


Fig. 4 – Habitat suitability for the otter recorded in each of 114 units of 1 km<sup>2</sup> of the Ticino valley.

Tab. 3 – Fish biomass estimated (S.D. = Standard Deviation) in some water bodies of the Ticino valley and in two rivers hosting otters (southern Italy).

	N	MEAN (KG/HA)	MIN-MAX	S.D.
<b>TICINO VALLEY</b>				
Oxbow lakes	4	302.0	127.5-435.2	129.9
Canals	3	87.1	27.9-148.6	60.4
Stretches of Ticino river	2	152.9	123.5-182.2	41.5
Total	9	197.2	27.9-435.2	134.1
<b>AGRI AND BASENTO RIVERS</b>				
Stretches of river	14	118.9	1.9-316.3	102.1

Most suitable habitats for the otter were distributed along the main course of the Ticino river, while there were very few and scattered suitable sites in the remaining territory of the valley (Fig. 4). The 1 km<sup>2</sup> territorial units with moderate/very good suitability occupied the 16.7% of the study area and those with low suitability the 38.1% (Tab. 4).

Tab. 4 – Subdivision of the Ticino valley (1114 units of 1 km<sup>2</sup> each) according to habitat suitability classes for the otter.

SUITABILITY CLASSES	NO OF UNITS (KM <sup>2</sup> )	%
Not suitable	504	45.2
<b>LOW</b>	424	38.1
Moderate	141	12.7
Good	37	3.3
Very good	8	0.7

## DISCUSSION

Several factors are involved in the decline in both population and range of the otter, especially over much of western Europe. The most important of these are pollution, habitat destruction, disturbance and overhunting (e.g. Mason & Macdonald, 1986).

Bisogni et al. (1992) examined the main chemical-physical parameters (e.g. pH, Cr, Hg, phosphates, nitrates, BOD, dissolved oxygen, ammonia) collected by several authors in the Ticino river from 1982 to 1992, and concluded: "Comparing these data with the standard levels listed by the National Legislative Decree No. 130/92, it is possible to indicate that the water quality of the Ticino river is generally good; pollution occurs downstream of the confluence between some little tributaries and the Ticino river". This picture is also confirmed by the biological water quality, assessed by using the E.B.I.

For the Ticino river heavy metal levels in fish tissues are not available. On the other hand some fish species (*Alburnus alburnella alburnella*, *Coregonus* sp., *Perca fluviatilis*), collected in the Maggiore Lake of which the Ticino river is the main tributary, were analyzed for mercury, the most important heavy metal for the public

health. The values were lower than the standards proposed by the Italian legislation (0.7 mg/kg of fresh weight) and by the Swiss legislation (0.5 mg/kg of fresh weight) (Istituto Italiano di Idrobiologia - CNR, 1992).

The concentration of PCBs and DDT in fish tissues from the Ticino river does not exceed the critical levels proposed by the National Academy of Science of USA for fishes preyed on by carnivores.

The water quality level of the Ticino river seems to be suitable for maintaining fairly good fish populations. The river is full of fish and for this reason supports a high fishing pressure. Pollution, mainly due to agricultural activities (e.g. rice cultivation), seems to deplete fish resources of some little tributaries. In some cases, fish carrying capacity of these effluents could also be reduced by the effects due to the gravel extraction.

A large part of the Ticino valley is a regional park with different degrees of protection of the territory. The most important zones are Integral Reserve. This guarantees the conservation of natural vegetation cover, especially along the river and its main tributaries. On the other hand losses of riparian cover occurs in agricultural land, mainly in streams, irrigation canals and ditches. In some stretches, bankside vegetation is cleared to allow access to heavy machinery where water bodies are to be modified for improving land drainage.

The Ticino valley has a high population density and recreation activities are widespread. Angling and the large use of boats could interfere with the behavioural activity of the otter, especially in sites of vital importance for breeding or foraging. However, several studies suggest that otters are not so sensitive to human disturbance as one could suppose (Mason & Macdonald, 1986). Riparian habitats of the Ticino river seems to offer a wide variety of sites where otters could find suitable shelters.

The general habitat quality of the Ticino valley seems to be still suitable to the otter. A stretch of about 80 km in length shows a good continuity of suitable habitats. In southern Italy stretches of similar length maintain resident otter populations, though the general condition of the water quality and fish resources are lower than those recorded in Ticino river. In western Spain, Ruiz-Olmo et al. (1991) indicate 100 km as the most favourable length of river for supporting a viable otter population.

The reintroduction of the otter is encouraged when the original causes of extinction have been controlled or removed, and the habitat is still suitable for the species (IUCN, 1987). The Ticino river seems to satisfy these conditions. Nevertheless, a policy of habitat restoring, especially in agricultural land, is very important in order to improve the habitat quality for the otter. This intervention should have to include also other surrounding rivers, especially the Po river, in order to increase the suitable area for otters.

The project of reintroduction of the otter in the Ticino valley could be of particular importance in order to stimulate the governments of the regions of north-western Italy to promote restoring programs of riverine areas, allowing the realization of a network of suitable habitats for otters (Reuther, in this volume).

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