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## THE RETURN OF OTTER (*LUTRA LUTRA*) IN HAUTE-SAVOIE (FRANCE): DEVELOPMENT OF A NEW METHOD OF HABITAT ANALYSIS

François JACQUET<sup>1</sup>

RÉSUMÉ. — *Le retour de la Loutre d'Europe (Lutra lutra) en Haute-Savoie (France): développement d'une nouvelle méthode d'analyse de l'habitat.* — Bien que la Loutre d'Europe soit considérée comme disparue de la Haute-Savoie depuis le début des années 1980, des indices certains de sa présence y ont été recueillis durant les dix dernières années, en particulier dans la vallée de Chamonix. Néanmoins le statut de cette espèce demeure très précaire, car le nombre d'individus qui compose sa population dans ce département reste faible, et son habitat souffre de dégradations liées aux activités humaines. En conséquence, il est intéressant et utile de savoir si la Haute-Savoie offre un habitat favorable à la Loutre d'Europe, et si le retour d'une population stable et dynamique de cette espèce y est possible. Pour répondre à cette question, nous développons une nouvelle méthodologie d'analyse de l'habitat prenant en compte toutes les variables qui influent sur la survie et la distribution de la Loutre d'Europe. Son intérêt est d'obtenir un indicateur direct global de la qualité de l'habitat pour cette espèce. Nous appliquons cette méthode au département de la Haute-Savoie. **La conclusion est que ce dernier offre un habitat favorable à la Loutre d'Europe. Il serait intéressant d'appliquer notre méthode à d'autres régions où l'espèce est présente, afin de la tester et de l'affiner : elle pourrait ainsi devenir un outil standard d'évaluation de la qualité d'un habitat pour la Loutre d'Europe.**

SUMMARY. — Although Otter has been considered as extinct in Haute-Savoie since the beginning of the 1980's, several reliable signs of presence of this species were noticed during the last ten years, especially in the Chamonix valley. Nevertheless, Otter's status remains very precarious, because the number of individuals that constitute the Otter population in Haute-Savoie is still very low, and because its habitat suffers from a lot of degradations due to human activities. As a result, it is interesting and useful to know if Haute-Savoie offers a favourable habitat to this species, and if the return of a stable and dynamic Otter population is possible. To answer this question, we develop a new method of habitat analysis, which takes into account all the variables of the habitat that have an influence on Otter's survival and distribution. The interest of this method is obtaining a synthetic index, which directly reflects the quality of the habitat for the Otter. We apply this method to the department of Haute-Savoie. The conclusion is that indeed Haute-Savoie possesses a habitat favourable to the Otter. It will be interesting to apply our method to other areas where Otter is present, to test and refine it so that it could become a standard tool to assess the quality of a habitat for Otter.

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The French population of Otter is divided into three main areas: Brittany, Atlantic coast and Massif Central. It is estimated at 1500 to 2000 individuals (Bendelé, 2001). Although this species was formerly widespread in the whole French territory, its populations suffered a great decline in the 19<sup>th</sup> and 20<sup>th</sup> centuries, because of intense hunting, and later, from the second half of the 20<sup>th</sup> century, because of river pollution. Having come very close to extinction, Otter became a protected species in 1973. Although it is always regarded as a highly endangered species, its populations are nowadays expanding.

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In Haute-Savoie as in the whole Rhône basin, Otter has been considered as extinct since the beginning of the 1980's (Michelot, 1992). Nevertheless, during the last ten years, field surveys revealed the existence of two populations in the upper Rhône valley, one in the lower part of Ain (Bouchardy & Boulade, 2005), and the other in the upper part of Arve (Jacquet, 2007; Bouchardy & Boulade, 2008). In these areas, reliable evidences of presence were found continuously from 2002 to 2007 although field surveys lead by Christian Bouchardy and Yves Boulade in 2007 in Ussets, Fier, Lac du Bourget, Savière Waterway, Chautagne Marsh and Lavours Marsh gave negative results (Bouchardy & Boulade, 2008). These data are consistent with a recent increase of a relict Otter population so far gone unnoticed. This does not exclude the possibility of a dynamic recolonization of the Rhône and some of its tributaries that could enhance the Otter population in Haute-Savoie.

So, Otter is present in Haute-Savoie, but its status remains precarious. The aim of this paper is to determine whether the habitat in Haute-Savoie is of a sufficient quality to allow the return of this species and the development of its populations. To answer this question, we built a new exhaustive method that allows analysing the biotic and abiotic variables that characterize the Otter habitat.

## MATERIALS AND METHODS

### DEVELOPMENT OF A METHOD OF HABITAT ANALYSIS

#### *Literature review: identification of habitat variables influencing Otter's repartition*

The first step of our work was to identify all the habitat variables that have an influence on the distribution of the Otter. These variables are biotic and abiotic (Tab. I, column A). Literature was widely reviewed. Nevertheless, only few of these variables are precisely defined. Information remains always quite imprecise and hypothetical (Weber, 1990). Habitat models for Otter have been described, but they are only available for restricted areas and cannot be used for others (Müller *et al.*, 1976; Weber, 1990). As a result, we had to extract information from several different publications (Tab. I, column A).

#### *Establishing a rating scale for each variable of the habitat*

After all the habitat variables that influence Otter's distribution had been listed, a rating scale was established for each of them (Tab. I, column C). This kind of rating scale has been used by Mason & Mac Donald (1986) to determine the quality of the shelters along a watercourse, on the first 100 m inland from bank. Nevertheless, the authors have not implemented this method to other habitat variables. In our case we used the following scale to rate each habitat variable (in terms of quality for the Otter): 1 = very poor; 2 = mediocre; 3 = average; 4 = good; 5 = very good.

Variable states ranked higher than 3 are favourable to the Otter whereas those lower than 3 are unfavourable. Those ranked 3 are neither favourable nor detrimental to the species.

Due to a lack of precision in the available bibliographic data, the rating scale of some variables consists of less than 5 ranks (Tab. I, column B).

This rating of habitat variables allows computing for each habitat a synthetic index reflecting its quality so that an Otter population can settle and develop there.

#### *Field application of the method*

We now have a method that allows defining the biotope quality for Otter, by analysing each variable independently. The next step is its application in the field. The bibliographic data concern watercourses. A section of watercourse, on which our rating method is applied, is defined as study area. For each variable, the most appropriate state is chosen and given a rank from 1 to 5. When the study area is large, its division into small sections allows a more precise characterization of the habitat. A lot of information is necessary to determine the state of each variable. These data can be obtained from various agencies (Tab. I, column C) or after a meticulous work in the field.

After being collected, data are compiled in a table (Tab. II) and processed. For each watercourse section, a mean score, between 1 and 5, is calculated by attributing *a priori* to each variable rate a coefficient equal to 1. At a larger scale, it is possible to calculate an index for a river including several sections, by weighting the score of each section by its length (Tab. II).

The total score that is calculated, for a single section of watercourse, a river, a catchment basin or a region, allows determining the quality of a habitat for the Otter, i. e. its ability to satisfy the species requirements. Between 3.5 and 5, indices indicate that the habitat is favourable to the Otter, between 2.5 and 3.5 that it is a sub-favourable habitat, and lower than 2.5 that it is an unfavourable habitat.

TABLE I  
*Variables of the habitat which have an influence on the survival and the distribution of the Otter and values attributed to each state*

	Column A Variables of the habitat which have an influence on the survival and the distribution of the Otter	Column B Rating scale with values attributed to each state	Column C Sources of informations used in our study
Food resources	a. Abundance: fish biomass (Weber, 1990)	1 = less than 50 kg/ha 2 = between 50 and 100 kg/ha 3 = between 100 and 150 kg/ha 4 = between 150 and 200 kg/ha 5 = higher than 200 kg/ha	Results of electrical fishing made by the Fishing Federation of Haute-Savoie
	b. Composition of the fish biomass: predominant size class (number of individuals out of the total number) (Thom <i>et al.</i> , 1998)	3 = more than 25 cm 4 = between 15 and 25 cm 5 = less than 15 cm	
	c. Nature of the fish population: fish category (Bouchardy, 1986)	3 = first category (salmonids are predominant) 5 = second category (cyprinids, eels, sticklebacks, bullheads)	
	d. Abundance of the other sources of food (frogs, crayfish, reptiles) (Sidorovich & Pikulik, 1998)	1 = absent 2 = rare 3 = fairly numerous 4 = numerous 5 = very numerous	
Quantity and quality of shelters in the first hundred meters of bank	e. Density of shelters: percentage of covering of the bank by vegetation (Macdonald & Mason, 1985)	1 = absence of vegetation 2 = less than 25% 3 = 25 to 50% 4 = 50 to 75% 5 = 75 to 100%	Aerial pictures owned by ASTERS*
	f. Quality of the shelters: composition of the vegetation (Andrews, 1989)	1 = no vegetation 2 = low and herbaceous vegetation 3 = high and herbaceous vegetation (ferns, reeds, ...) 4 = shrubby vegetation (hawthorn, bramble, gorse bush, wicker, ...) 5 = arborescent vegetation	
	g. Distance from water of the vegetation or the other kinds of shelters (Macdonald & Mason, 1985)	1 = more than 100 m 2 = 75 to 100 m 3 = 50 to 75 m 4 = 25 to 50 m 5 = less than 25 m	
	h. Kind of shelters for reproduction (Macdonald <i>et al.</i> , 1978; Mason & Macdonald, 1986)	1 = no tree or other kind of shelter 3 = beech, birch, maple, hazel, holly, rowan, lime tree, hawthorn 4 = other kinds of shelters (rocks, burrows) 5 = ash, sycamore, oak, elm	

Quality of water	<p>i. Quality as regards toxic elements for Otter (cadmium, mercury, lead, PCBs) (Weber, 1990)</p> <p>j. Overall quality of the aquatic environment: IBGN (standard overall biological index)</p> <p>k. Variations of the water level, which entail a risk of flooding of the shelters used for reproduction (Libois &amp; Rosoux, 1992)</p>	<p>1 = bad 2 = mediocre 3 = average 4 = good 5 = very good</p> <p>1 = bad 2 = mediocre 3 = average 4 = good 5 = very good</p>	<p>Maps of Agence de l'Eau and DIREN** (the same quality grades are used)</p>
Hydrodynamic characteristics	<p>l. Risks of mortality by collision with vehicles (Bouchardy, 1986; Green, 1991)</p>	<p>1 = high 3 = average 5 = low</p> <p>1 = a road crosses the river with a high risk of collision (impossibility of going on the shore under the bridge) 2 = a road crosses the river with a low risk of collision (possibility of going on the shore under the bridge) 3 = a road is far less than 100 m from water 5 = no road far less than 100 m from water</p>	<p>Data from Agence de l'Eau or other agencies of environmental management</p>
Anthropogenic factors	<p>m. Moment of appearance of the disturbances due to human activities (Rosoux &amp; Green, 2004)</p> <p>n. Intensity of the disturbances due to human activities (Rosoux &amp; Green, 2004)</p>	<p>1 = diurnal and nocturnal or only nocturnal 3 = only diurnal 5 = no disturbance</p> <p>1 = constant human activities (town, civil engineering all the year) 3 = occasional human activities (fishing, water sports) 5 = very low (wildlife parks, inaccessibility)</p>	<p>Aerial pictures owned by ASTERS*</p> <p>Data of the Fishing Federation of Haute-Savoie (frequented by fishermen), websites of water sports clubs and associations and maps about use of the aquatic environment (DIREN**)</p>
Conformation of the biotope	<p>o. Obstacles in the Otter territory (Green &amp; Green, 1994)</p> <p>p. Richness of the biotope (Bouchardy &amp; Boulaide, 2005)</p>	<p>1 = obstacle hard to cross 3 = obstacle easy to cross 5 = no obstacle on the study area</p> <p>3 = poor biotope (river without any element of diversification) 5 = rich biotope (backwaters, lakes, ponds along the river)</p>	<p>Aerial pictures owned by ASTERS*</p>

\*ASTERS = Conservatoire des espaces naturels de Haute-Savoie

\*\*DIREN = Direction régionale de l'environnement

TABLE II

Values of the 16 variables for the sections of the study area and overall marks of habitat quality that can be calculated

Section	Value of the variable “a”	...	Value of the variable “p”	Overall index of the section	Length of the section
1	a <sub>1</sub>	...	p <sub>1</sub>	n <sub>1</sub> = (a <sub>1</sub> +...+p <sub>1</sub> )/16	l <sub>1</sub>
...	...	...	...	...	...
X	a <sub>x</sub>	...	p <sub>x</sub>	n <sub>x</sub> = (a <sub>x</sub> +...+p <sub>x</sub> )/16	l <sub>x</sub>
T=1 to x	A <sub>1-x</sub>	...	P <sub>1-x</sub>	N <sub>1-x</sub> = (n <sub>1</sub> .l <sub>1</sub> +...+n <sub>x</sub> .l <sub>x</sub> )/L <sub>1-x</sub>	L <sub>1-x</sub> = l <sub>1</sub> +...+l <sub>x</sub>

APPLICATION OF THIS METHOD TO RIVERS IN HAUTE-SAVOIE

*Definition of the study area*

The watercourses of Haute-Savoie we chose as study areas were selected according to two criteria. We first retained the places where reliable signs of the presence of the Otter had been noticed since 2000. This allowed testing our analytical method. We added places for which we had a lot of information, particularly values of fish biomass. Indeed this habitat variable is one of the most important for Otter’s survival (Weber, 1990). Some biomass values are old, but the situation of fish populations of Haute-Savoie has little changed in recent years (Caudron, pers. com.). The problem of this method of choice is a bias in the sampling. Nevertheless, figure 1 shows that the study area covers most of the main catchment basins of Haute-Savoie, i. e. Arve, Usse and Fier (by Chéran and Daudens, two of its tributaries). Only Lake Geneva catchment basin was not studied.

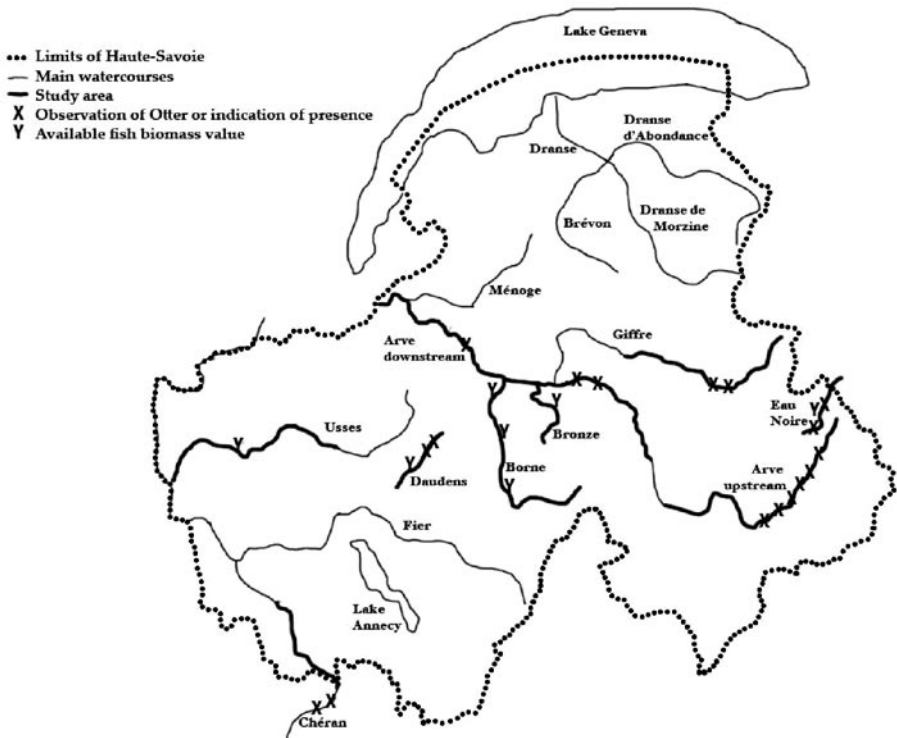


Figure 1. — Study area in Haute-Savoie.

This method of selection allows only having reduced areas (Fig. 1). So we had to define a watercourse length that will be studied. According to various studies, an Otter territory extends along 10 to 40 km of river (Erlinge, 1968; Green & Green, 1994). We opted for the highest value. As a result, study areas ranged from 20 km upstream to 20 km downstream of each place where Otter was positively present or where a measure of fish biomass was available (Fig. 1). The total study area covered 233.4 km of watercourses (Arve, Giffre, Borne, Bronze, Eau Noire, Daudens, Chéran, Usses) and was divided into linear sections of 1 to 3 km long.

### *Sources of information*

The sources of information we used to assign a state to each variable are mentioned in table I (column C). Because of time constraints, it was not possible to carry out an analysis of the habitat in the field. That is why the variable “kind of shelters for reproduction” was not studied in this work, because it requires a very demanding work in the field. Besides, we did not analyse the variable “variations of the water level”, because of a lack of available data.

## RESULTS

### RESULTS FOR THE VARIOUS STUDIED WATERCOURSES

The average index of the study area is equal to 3.66 out of 5, so the habitat of Haute-Savoie is favourable for Otter. No watercourse is unfavourable (Tab. III).

TABLE III  
*Overall indices attributed to the watercourses of our study area*

Watercourse	Overall index	Lower altitude (m) of the study area	Higher altitude (m) of the study area
Usses	4.1	270	550
Chéran	4.1	360	560
Daudens	4.0	557	941
Arve aval	3.7	390	520
Giffre	3.7	665	1222
Borne	3.6	440	1275
Bronze	3.6	455	2140
Eau Noire	3.4	1094	2579
Arve amont	3.1	550	1710

Usses is one of the main catchment basins in Haute-Savoie. The habitat is favourable for Otter (4.1 out of 5) (Tab. III). It is relatively protected from human activities. The vegetation of the shore is abundant and offers a lot of shelters. Water quality is good. Food resources are also good.

Chéran is a tributary of Fier, whose catchment basin is a main one too in the department. The habitat is favourable (4.0 out of 5), because of low anthropization, banks with abundant vegetation and good water quality (Tab. III). Food resources have an average quality. Daudens, another tributary of Fier, represents a favourable habitat too, although food resources are of lower quality.

Arve is the main catchment basin of Haute-Savoie. Arve and some of its tributaries are included in our study area. Arve downstream and its tributaries, Giffre, Borne and Bronze, offer a favourable habitat (3.6 to 3.7 out of 5) (Tab. III). Despite an important anthropization with a lot of roads and towns, especially along Arve, the habitat remains relatively preserved.

The presence of sufficient vegetation on the shore is constant. Food resources of Giffre are bad. Fish biomass is certainly lower than 25 kg/ha (Caudron, pers. com.). The mountainous relief entails a low availability of shelters.

Arve upstream offers a sub-favourable habitat for Otter (3.1 out of 5) (Tab. III). The only good quality variable is the presence of rich vegetation on the shore. Various variables have an unfavourable state. Water quality is very bad and the roads are numerous and really close to the river. Fish biomass is very low in Arve upstream, surely lower than 50 kg/ha (Caudron, pers. com.).

Eau Noire offers a sub-favourable habitat (3.4 out of 5) (Tab. III), with a low anthropization, a sufficient availability of shelters and a good quality of water. Nevertheless, there is a risk of mortality by collision with vehicles and the food resources are of bad quality.

#### RESULTS FOR THE VARIOUS VARIABLES OF HABITAT

The department of Haute-Savoie offers a favourable habitat to Otter, especially with regard to shelters and conformation of the biotope (4.1 out of 5) (Tab. IV). Banks offer dense vegetation of good quality composition. There is no impassable obstacle (hydroelectric dams for example) in our study area and the biotope shows many elements of diversification, such as secondary branches or ponds along the watercourses.

TABLE IV

*Overall indices calculated in the study area for each variable of the habitat*

Variable of the habitat		Overall indices	
Food resources	a. Abundance (fish biomass)	3.2	3.6
	b. Composition of the fish biomass (predominant size class)	4.4	
	c. Nature of the fish population (fish category)	3.0	
	d. Abundance of the other sources of food (frogs, crayfish, reptiles)	3.8	
Quantity and quality of shelters	e. Density of shelters (covering of the bank by vegetation)	3.2	4.1
	f. Quality of the shelters (composition of the vegetation)	4.6	
	g. Distance from water of the vegetation or the other kinds of shelters	4.6	
Quality of water	h. Quality as regards toxic elements for Otter (cadmium, mercury, lead, PCBs)	3.1	3.2
	i. Overall quality of the aquatic environment (IBGN)	3.3	
Anthropogenic factors	j. Risks of mortality by collision with vehicles	2.9	3.2
	k. Moment of appearance of the disturbances due to human activities	3.5	
	l. Intensity of the disturbances due to human activities	3.2	
Conformation of the biotope	m. Obstacles in the Otter territory	4.9	4.1
	n. Richness of the biotope	3.3	

Food resources are of good quality (3.6 out of 5) (Tab. IV). Nevertheless, fish biomass values are variable and very low in some watercourses like Arve or Giffre, surely lower than 50 kg/ha (Caudron, pers. com.). There are enough other sources of food (amphibians, crayfish, etc.), but most of the studied watercourses are classified as first category (predominance of salmonids in the fish population), except for the lower part of Usse which is classified as second category (predominance of cyprinids). Salmonids are more difficult to hunt by Otter than cyprinids which are slower and live in less turbulent waters.

Haute-Savoie suffers from an important anthropization, that entails a classification of the variables related to water quality and human factors as sub-favourable (3.2 out of 5) (Tab. IV). In valleys, roads are numerous and often follow the watercourses. The risk of mortality by collision with vehicles is high.



## DISCUSSION

### BENEFITS AND DRAWBACKS OF THE METHOD OF HABITAT ANALYSIS

The method of analysis that is developed in this paper consists in a new tool to assess the quality of the habitat for Otter.

#### *Benefits*

This method allows making an exhaustive processing of all the variables of the habitat that have an influence on Otter distribution, and then to obtain a synthetic index that reflects the quality of the habitat for the development of this species. The definition of simple states for each variable allows limiting the bias linked to the observer and ensures the reproducibility of the study. This method could become a standard tool to compare several potential habitats and habitats where Otter lives. It could therefore help to identify priority measures of habitat restoration and to make predictions on the recolonization of a watercourse, by taking into account the dynamics of the neighbouring populations. It would also be possible to use this method to estimate the quality of biological corridors, which are required for the recolonization of a habitat. In this case, it might be possible to exclude some variables or to apply a less severe rating scale, because requirements of Otter in these places of passage are less stringent than where the species is established in the long-term.

#### *Drawbacks*

This method of habitat analysis presents some drawbacks. On the one hand, the correlation between some variables is not taken into account. For example, there is a link between disturbances due to human activities and availability of shelters, because Otter can tolerate disturbances when shelters are numerous enough. On the other hand, despite the important literature reviewed and the consultation with several naturalists, some values used to determine the state of variables remain arbitrary, as for the size classes of fish.

#### *Prospects of this method*

Our method needs to be tested at a larger scale to be validated. It is surely possible to apply it to other kinds of habitats than watercourses, such as seaside or lakes and ponds, because the Otter's biological requirements remain the same. Further applications can allow refining the method. Indeed, a coefficient equal to 1 is *a priori* assigned to the rating of each variable, but it might be better to give more weight to some variables. Moreover, some authors do not agree on the impact of some variables on Otter distribution. For example, some studies show no statistical correlation between Otter distribution and the presence of easy-to-access vegetation on the shore (Jenkins & Burrows, 1980; Thom *et al.*, 1998). Bertrand & Blanchon (1981) have noticed the presence of Otter along channels in marshes in Charente, whose shores offer very sparse vegetation. As a result, the rating scale for some variables may be a little severe and will have to be slightly modified.

### COMMENTS ON THE RESULTS

The quantity of food, expressed as the fish biomass, is the most important habitat variable for the Otter's survival. As fishes constitute the main part of its diet, a fish biomass higher than 100 kg per hectare is sufficient. A fish biomass lower than 50 kg/ha is insufficient. Between these two values, the survival of the Otter is uncertain (Weber, 1990). Although Haute-Savoie offers a favourable habitat, this variable has one of the worst indices (3.2 out of 5) (Tab. IV). This is a negative aspect as regards the return of the Otter in this department. Nevertheless, the values determined by Weber do not take into account the other food sources (amphibians, crayfishes, reptiles, small mammals and birds, insects, berries, etc.), which are essential when fish populations are insufficient. Our study shows that these other food sources are abundant enough in Haute-Savoie (3.8 out of 5) (Tab. IV).

The risks of mortality by collision with vehicles are very high in Haute-Savoie, because roads in valleys are numerous and follow and cross watercourses. This risk and the insufficient fish biomass in some watercourses constitute the two worst aspects of the habitat as regards the return of the Otter in Haute-Savoie.

The quality of water on the whole department is average. Nevertheless, the rating scale may be a little severe. Indeed, it is difficult to make an accurate correlation between the values seen in our literature review on contamination of fishes and the values sent to us by DIREN (Direction régionale de l'environnement) and Agence de l'Eau on water contamination. The pollution levels that represent a risk for Otter survival are surely much higher than those that allow considering a water quality as bad. So the current pollution levels of heavy metals and PCB (polychlorinated biphenyls) in Haute-Savoie surely represent only a low risk for the Otter. It is important to notice that many efforts have been made in the last years in the Arve valley in order to reduce discharges from factories in watercourses.

The rating scale for the two variables on disturbances due to human activities may be a little severe too, because activities like water sports, fishing or agriculture, which are only diurnal, have surely only a little influence on Otter distribution.

Our study shows that low valleys (Usses, Chéran, Daudens) offer a more favourable habitat than high ones (Borne, Bronze, Eau Noire, Arve upstream) (Tab. III). The main explanation is a diminution of food resources when altitude increases. The low valley of Arve is a counterexample. Although the altitude is low, the rating of habitat quality is not one of the highest (3.7 out of 5), especially because of an intense anthropization, which entails a degradation of habitat for several variables.

#### LINK BETWEEN THE QUALITY OF HABITAT AND THE DISTRIBUTION OF OTTER IN HAUTE-SAVOIE

It is possible to make a link between the quality of habitat and the available data on Otter distribution in Haute-Savoie. Several reliable accounts support the presence of the Otter in Chamonix valley and in Arve downstream near Bonneville (Jacquet, 2007). Surveys conducted in the department in 2007 by Christian Bouchardy and Yves Boulade have confirmed the presence of this species on Giffre and Arve, with a high density in Chamonix valley (Fig. 1). Surveys on Usses and Fier yielded negative results (Bouchardy & Boulade, 2008). Otter is currently absent on these watercourses.

It is surprising to see that most accounts come from watercourses whose habitat is the less favourable of our study area, *i. e.* Arve upstream (3.1 out of 5) (Tab. III). *A contrario*, Usses offers one of the most favourable habitats (4.1 out of 5), whereas no sign of presence has been discovered during surveys by Bouchardy and Boulade. Nevertheless, all the other reliable signs of presence of Otter come from watercourses whose habitat is favourable, as Chéran (4.1 out of 5), Arve upstream (3.7 out of 5) or Giffre (3.7 out of 5) (Tab. III).

Because of the low number of surveys, which were essentially led in Chamonix valley, and because of the recolonization movement to which the current Otter populations are prone, it is very difficult to draw any firm conclusion.

#### CONCLUSION

Habitat in Haute-Savoie is favourable for Otter, despite a high development of human activities and low values of fish biomass in some watercourses, especially in the Arve basin. No variable of the habitat is unfavourable. Water quality and availability of shelters are good. So, as regards habitat quality, the return of Otter in Haute-Savoie is possible. Nevertheless, the dynamics of the population has to be taken into account to know if such a return is practically possible or not. It is difficult to know if the individuals that are present in the Chamonix valley are numerous enough to constitute a strong and dynamic population. A strengthening thanks to colonization by individuals from neighbouring populations could contribute to the return of the species. Only one population of Otter is strong and dynamic enough to provide individuals that could colonize Haute-Savoie. This population is located in Ardèche up to the confluence with Rhône and has been greatly expanding for ten years (Dupieux, 2006). It is possible that some individuals that are present in Ain or Haute-Savoie come from Ardèche.

Our conclusions on the quality of habitat in Haute-Savoie were drawn thanks to the development of a new method of analysis which, however, has to be used in other areas, especially where a strong and stable population is present. This could allow testing and refining it. It might be better to assign higher coefficients to some variables which have a great impact on Otter survival, like fish biomass or risks of mortality by collision with vehicles. Values for some variable states, such as water quality or disturbances due to human activities, might have to be changed because their rating scales might be too severe. This method could become a useful tool to assess the quality of the habitat for Otter.

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