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Otter Conservation – An Example for a Sustainable Use of Wetlands

March 14-19, 1998
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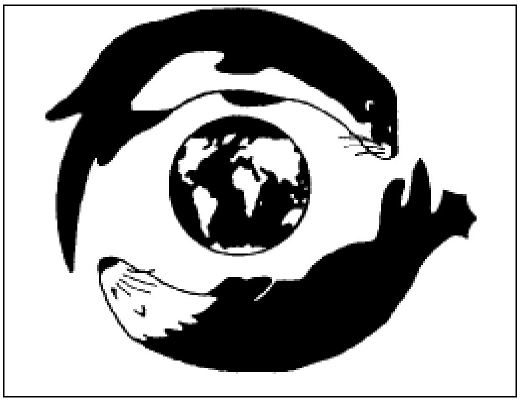

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INFLUENCE OF HABITAT QUALITY FACTORS ON OTTER (*Lutra lutra* L.) DISTRIBUTION IN BRITTANY, NW FRANCE A STATISTICAL APPROACH FOR ASSESSING RECOLONIZATION PROBABILITIES

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Abstract: Brittany, NW France (28,077 km^2) is a region showing strong disparities in otter distribution, and also in hydrogeographical factors and land use. So this situation offered a good opportunity to compare these different criteria with otter distribution as indicated by occurrence levels, through a multifactorial analysis on the scale of water catchment subunits (n=295). Of 18 factors tested, 13 appeared to be statistically correlated with otter distribution ($P<0.05$), along two poles joining respectively hydrological and man-caused factors. In particular five factors link these two poles: hinterland physiognomy, rate of drained/irrigated land, general watercourse quality, overall nitrogen excess and overall fish biomass. For each factor the thresholds have been estimated beyond which otters are, respectively, mainly absent, or resident/widespread. Perspectives for understanding the role of antagonist factors in otter distribution on a large enough scale, and predicting short-term recolonisation movements are discussed.

INTRODUCTION

For the last two decades, several studies have examined the relative influence of different habitat quality factors on otter occurrence, but often on a restricted scale (sites, according to "standard" methods for otter surveys; e.g. MADSEN (1996), (PRENDA and GRANADO-LORENCIO, 1996), despite the fact that otter (*Lutra lutra*) ranges are considerably larger. PRAUSER and RÖCHERT (1991) have underlined the need to examine various parameters on different scales (region, water system, site) and recently, concerning the effects of PCBs on otter, KRUUK (1997) has pointed out the importance in differenciating individuals and populations.

STUDY AREA

Brittany, NW France (28,077 km^2, 47°13'-48°50' N, 1°-5°10' W; Fig. 1) is a region showing strong disparities in otter distribution (Fig. 2), and also in hydrogeographical factors and land use, especially in agriculture. For instance, this is one of the first European regions for pig production (in the early 90s, with more than 6.1 million pigs being produced a year, this compares with three million people inhabiting the region). This farming has a well known impact on water quality degradation. In this paper, all data (otter occurrence, environmental factors) are formatted on a large scale: the subunits of water catchments (n=295, mean surface area: 95.2 km^2, namely equivalent to 10x10 km UTM squares), regularly used by the water autorithies.

Figure 1. Study area

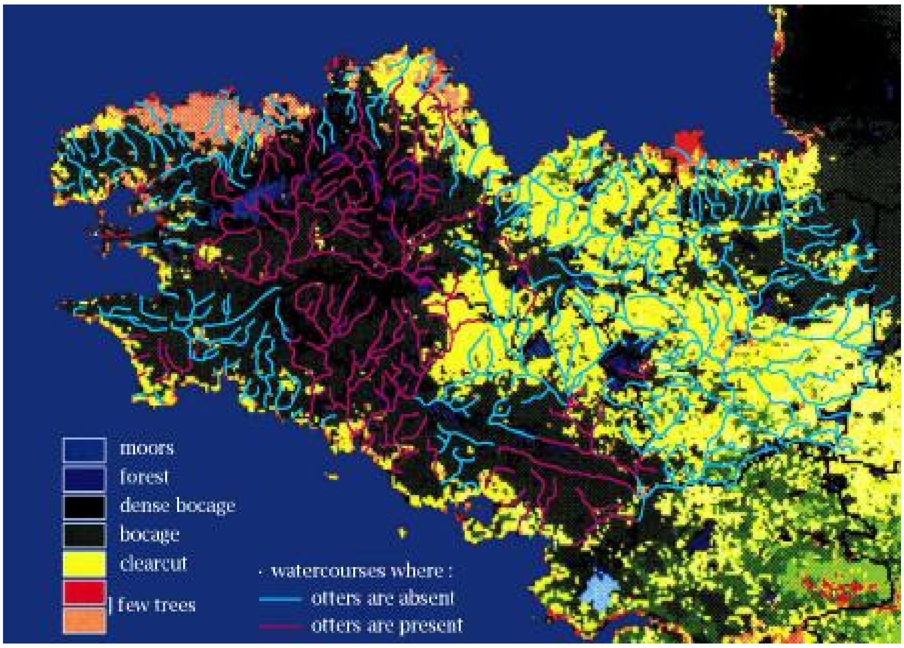

Figure 2. The rural landscape typology (hinterland physiognomy factor) shows in Brittany strong disparities, particularly between the western and eastern halfs, such as other related factors (Map from NOAA satellite pictures, processed by V. Dubreuil / Costel Team, University of Rennes 2, France). The superimposition of watersheds (and here associated watercourses) used or not by otters shows the highest correlation concerning otter distribution vs all tested factors (c^2 = 97.37, *P*<0.001; see below).

MATERIAL AND METHODS

Regular otter surveys have been carried out, following the standard field recommendations (at each site, 600m of waterway searched for signs of otters), and at least 3 sites/100 km^2 surveyed. All data (corresponding here to the early 90s) are displayed by subunits of water catchments, and by occurrence levels as follows: otter absent (no signs), non-resident or confined to less than 50% of the subunit, and resident/widespread (LAFONTAINE, 1993).

All raw data concerning factors, which are thought to influence otter distribution have been collected and initially formatted on the basic scale of water catchments subunits. These raw data have been removed either from administrative reports and charts (rainfall: MÉTÉO-FRANCE; low run-off: VILLEY et al., 1993; general watercourse quality: AGENCE DE L'EAU LOIRE-BRETAGNE, 1989; human population density: INSEE, 1990; hinterland physiognomy: DUBREUIL, 1995; agricultural data: DRAF-BRETAGNE, 1990). Or when unpublished, the data have been provided by administrative authorities (hydrographic network length: 'Course' GIS hydrological data, LEPETIT et al. /DDAFs; fish data: Chapon and Porcher /CSP; overall nitrogen excess: AUROUSSEAU and BAQUÉ/LSSSN-ENSAR). Fish data have been collected throughout the region by electrofishing (43 fish species, 545 specimens from 1978 to 1990) and then processed by size biomass and density (following the Carle and Strub Method). Unfortunately some data, either unavailable or quantitatively insufficient on the regional scale (use of pesticides, fish contamination etc.), could not be tested.

For each factor, each subunit is characterized by qualitative levels (otter distribution, three levels, see above; general watercourse quality & hinterland physiognomy, five levels) or arithmetic means (all other factors characterized by numerical data).

The data were then statistically processed in a multifactorial analysis. The degree of closeness between each factor *vs* another is assessed by the χ^{2}-test for qualitative factors (nonparametric test), and the analysis of variance F test for quantitative ones (parametric test). Statistical tables give the respective significance levels (error threshold: *P*), according to the values of F and χ^2 and the sample size (degrees of freedom). The lower the value of *P*, the higher the significance and it is usually admitted that the test is significant when the error threshold (*P*) is lower than 5% (SIEGEL, 1956; WONNACOT and WONNACOT, 1991).

RESULTS

The results show that in the early 90s, otters were absent (no signs) in 205 subunits (18,305 km^2, 65.2%); non-resident or confined in 41 subunits (4,391 km^2, 15.6%); and resident/widespread on 49 subunits (5,381 km^2, 19.2%). Total used subunits: n=90, 9,772 km^2, that is to say 34.8% of the total surface of the region. Of the 18 factors tested, 13 appear to be statistically correlated with otter distribution ($P<0.05$), as shown by the contingency table (Table 1), and pointing out thresholds beyond which otters are respectively mainly absent, or resident/widespread (Table 2). The contingency table underlines two poles gathering respectively hydrological and man-caused factors. Five induced factors in particular link up these two poles: overall fish biomass, rate of drained/irrigated land, hinterland physiognomy, overall nitrogen excess and general watercourse quality (Fig. 3). For each subunit, the combination of each of the 13 factors gives an overall quality index map (5 levels, from unfavourable to favourable criteria, Fig. 4), showing otter populations are absent on subunits with the lowest quality index (level 1), and mainly resident/widespread on the most favourable one (level 5).

DISCUSSION

The combination of several unrelated factors appears to be determinant for otter distribution, via the particular link of the induced factors, among which three show favouring effects: overall fish biomass, hinterland physiognomy and general watercourse quality (and all hydrological factors), whereas the two others show limiting effects: rate of drained/irrigated land and overall nitrogen excess (and man-caused factors). These results suggest the role of several antagonistic factors in otter distribution on a large enough scale, and in particular the positive effects of factors favouring subunits where man-caused effects are very prominent. It suggests also that one single factor, such as food availability, depends on other factors, positive or negative, and that otter distribution is linked to the combination of themall. Of course several data expected to show an impact on otter populations have not been processed here, such as use of pesticides and fish contamination, because such data were unavailable on a large scale.

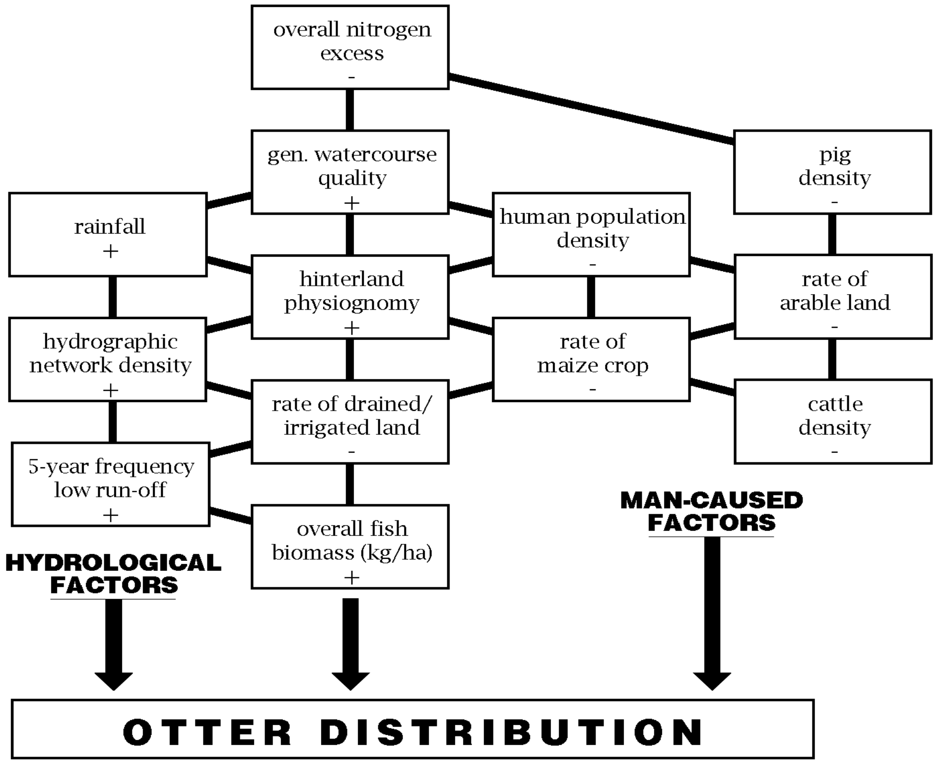

Figure 3. Strongest correlations and relative architecture between the 13 factors related to otter distribution; the second left column displays the 5 induced factors linking up hydrological and man-caused poles (+ : favourable factors; - : limiting factors).

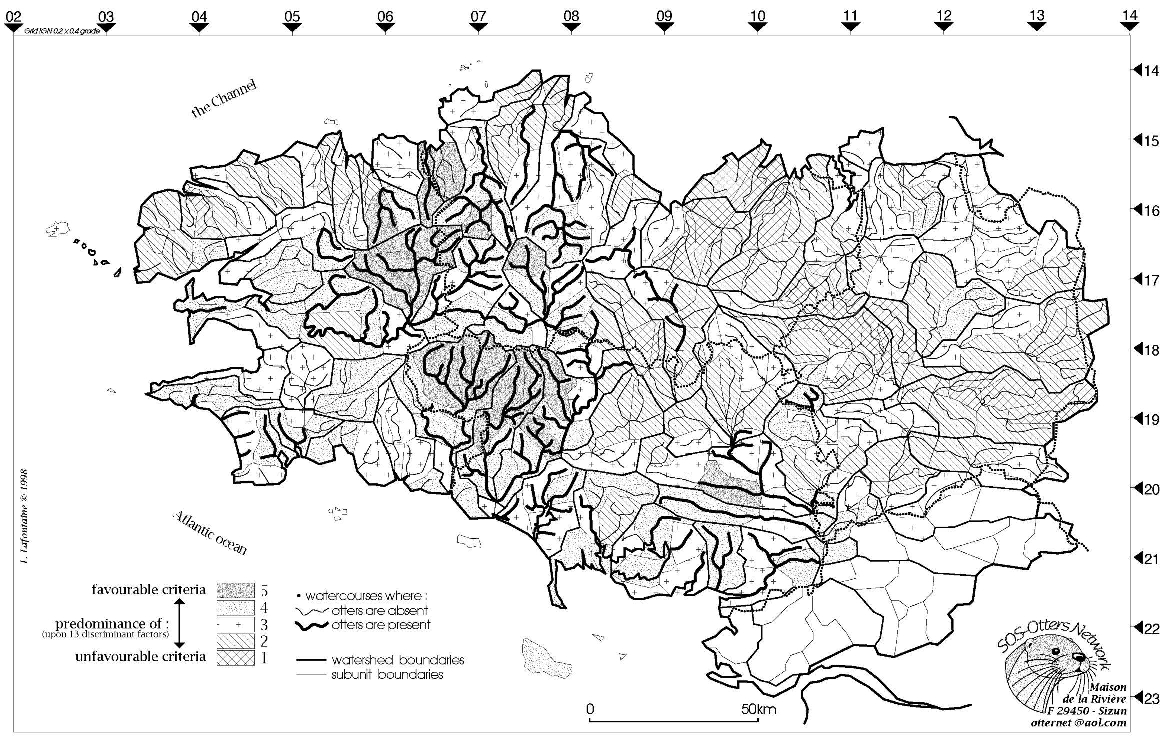

Figure 4. Overall quality index map, showing the combination of 13 factors related to otter distribution (see text). The quality index is distributed from the level 1 (lowest quality) to the level 5 (highest quality). Level 3 is intermediate.

Table 1. Respective values of F and c^2 and significance levels between each of the 13 factors related to otter distribution, on the scale of water catchments subunits (n=295)

66.76 •••	16.68 •	25.99 ••	17.91 •	87.77 •••	97.37 •••	31.16 •••	35.65 •••	40.08 •••	16.81 •	27.32 •••	35.01 •••	38.19 •••	otter distribution [OTD*]
[RFL]	[HND]	[LRO]	[OFB]	[DIL]	[HLP*]	[ONE]	[GWQ*]	[RMC]	[CAD]	[PID]	[ARL]	[HPD]	human population density [HPD]
Â	27.86 •••	44.39 •••	12.59 •••	36.24 •••	126.57 •••	11.88 •••	52.11 •••	0.49 ΔΔΔ	1.82 ΔΔ	0.86 ΔΔΔ	0.43 ΔΔΔ	3.21 Δ	rainfall [RFL]
	Â	7.34 ••	5.68 •	29.62 •••	39.41 •••	0.04 ΔΔΔ	17.97 ΔΔΔ	15.18 •••	6.89 ••	8.33 ••	4.76 •	1.24 ΔΔΔ	hydrographic network density [HND]
		Â	18.99 •••	8.38 ••	49.15 •••	13.00 •••	34.90 ••	10.71 ••	0.04 ΔΔΔ	3.12 Δ	0.09 ΔΔΔ	1.47 ΔΔ	5-year frequency low run-off [LRO]
			Â	14.59 •••	36.54 ••	0.07 ΔΔΔ	16.67 ΔΔ	4.23 •	7.90 ••	0.63 ΔΔΔ	8.30 ••	0.26 ΔΔΔ	overall fish biomass [OFB]
				Â	110.34 •••	14.93 •••	23.55 Δ	44.59 •••	92.16 •••	6.75 •	57.97 •••	0.36 ΔΔΔ	rate of drained/irrigated land [DIL]
					Â	21.21 ΔΔ	67.55 •••	135.18 •••	26.62 •	39.25 ••	70.47 •••	60.86 •••	hinterland physiognomy [HLP*]
						Â	24.10 Δ	0.07 ΔΔΔ	0.22 ΔΔΔ	305.94 •••	10.62 ••	2.88 Δ	overall nitrogen excess [ONE]
							Â	26.93 •	42.35 •••	28.72 •	33.21 ••	42.20 •••	general watercourse quality [GWQ*]
								Â	386.25 •••	47.61 •••	151.75 •••	14.23 •••	rate of maize crop [RMC]
									Â	38.24 •••	179.12 •••	55.35 •••	cattle density [CAD]
										Â	103.46 •••	5.04 •	pig density [PID]
											Â	39.55 •••	rate of arable land [ARL]

••• highly significant ($P<0.001$); •• very significant ($0.001 \leq P < 0.01$); • significant ($0.01 \leq P < 0.05$); Δ unsignificant ($0.05 \leq p < 0.10$); ΔΔ very unsignificant ($0.10 \leq P < 0.25$); ΔΔΔ : highly unsignificant ($P \geq 0.25$). (*) factors for which c^2 test has been used.

Table 1. Thresholds for each of the 13 factors, beyond which otters were mainly absent or resident/widespread in Brittany, on the scale of water catchment subunits.

thresholds beyond which otters are mainly :	absent	resident /widespread
1 : rainfall (mm.year^{-1})	<700	>900
2 : hydrographic network density (km.km^{-2})	<0.9	>1,3
3 : five-year frequency low run-off (l.sec^{-1}.km^{-2})	<0.2	>0.8
4 : general watercourse quality	middling	good
5 : overall fish biomass (kg.ha^{-1})	<120	>240
6 : human population density (.km^{-2})	>80	<50
7 : rate of arable land	>64%	<56%
8 : rate of maize crop	>20%	<12%
9 : rate of drained/irrigated land	>8%	<2%
10 : cattle density (.100ha^{-1})	>130	<80
11 : pig density (.100ha^{-1})	>400	<100
12 : overall nitrogen excess (kg.ha^{-1})	>170	<90
13 : hinterland physiognomy	clearcut	bocage

On the other hand, it allows us to predict short-term recolonization movements of otters: e.g. the one and only subunit with the best index unused by otters in the early 90's has been recently recolonized in 1996, and this situation can be expected on 19 subunits at least, mainly from the western half of the region. Adversely, according to this preliminary model, the recolonisation probabilities on the eastern part appear to imply the limitation of some unfavouring factors, because positive ones are generally less favourable. It is needed now to improve this model by adding more raw data, to update this situation from early 90s with regular evolutions of each factor, and to compare with other regions and countries, with a similar methodology.

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