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HABITAT AND FISH POPULATION PARAMETERS IN A HEADSTREAM

R.M. Cortés, J.P. Calçada Duarte & A. Monzón
Universidade de Trás-os-Montes e Alto Douro. 500 Vila Real. Portugal.

RESUM

Fou estudiada la influència que exercirien les característiques físiques de l'«hàbitat» en la densitat (N) i biomassa (B) de les poblacions de peixos del riu Olo, en el parc de l'Alvão (Nord de Portugal). A aquest efecte, es consideraren diverses estacions de mostreig al llarg de l'eix longitudinal, dins les quals foren considerades diverses sub-estaciones amb dimensions que es va procurar que abastessin els «macro-hàbitats» dominants.
L'angle del marge, el % de zona lèntica i la qualitat d'aquesta zona (mitjana pel mètode de Platts, 1983) constituiren les variables físiques que més influenciaren N i B seguides per la variable relativa a la vegetació ripícola, la qual cosa proveeix d'elements d'innegable valor sobre la necessitat de conservació dels «hàbitats».

RESUMEN

Fue estudiada la influencia que ejercerían las características físicas del «hábitat» en la densidad (N) y biomasa (B) de las poblaciones de peces del río Olo, en el parque del Alvão (Norte de Portugal). A tal efecto, se consideraron varias estaciones de muestreo a lo largo del eje longitudinal, dentro de las cuales fueron consideradas diversas sub-estaciones cuyas dimensiones se procuró que abarcaran a los «macro-hábitats» dominantes.
El ángulo del margen, el % de zona léntica y la calidad de esta zona (media por el método de Platts, 1983) constituyeron las variables físicas que más influenciaron N y B seguidas por la variable relativa a la vegetación ripícola, lo que provee de elementos de innegable valor sobre la necesidad de conservación de los «hábitats».

INTRODUCTION

Fish population numbers and biomass are notorious for wide fluctuations, either along the spatial gradient depending on the characteristics of the micro-habitats sampled (Welton et al., 1983, Sedell, 1984), and as well along the temporal gradient because of variations in year-class strenghts and seasonal variations in microhabitat utilization (Grossman & Freeman, 1987). In this study we did an attempt to evaluate the spatial variation of those two population parameters, in a mountain

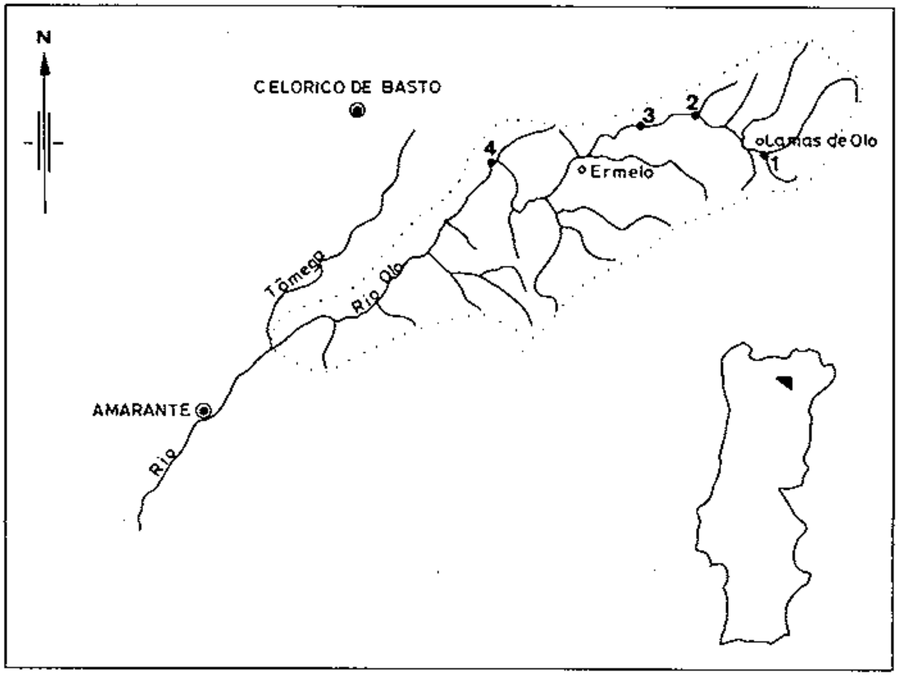

Figure 1. Study area and sampling stations.

stream poor in salts, variation considered for horitzontal axis but, mainly, observed in a smaller scale to determine the habitat use. Therefore, the objective consists on the identification of the abiotic factors more related with fish density and biomass, information valuable to assess the effects of possible habitat disturbance in this stream and, consequently, very important to define its management.

STUDY AREA

The Olo river, located in Northern Portugal (Fig. 1), was choosed for two reasons: by one side it represents a not eutrophicated ecosystem, flowing over a drainage basin covered with a dense forest, by other side the river is the central axis of Natural Park (Alvão), with an increasing human pressure. Thus, the assessment of physical impacts on habitats and its consequence on fisheries is strongly advised as the basis for the correct management. This ecosystem was already studied by Cortés et al. (1986) but mainly concerning the typology of the benthic fauna.

We can shortly characterize the stream, by its fast flowing waters, rocky bottom (mainly rubbles and boulders), low pH (≤ 6.5), low salt concentration (conductivity ≥ 40.0 umhos.cm-1) and high dissolved oxygen (OD-≥ 9.0 mg.l-1). A low autotropic production is the general faeature of this type of streams, and the aquatic macrophyte diversity is reduced to *Fontinalis antypiretica*, *Ranunculus peltatus peltatus*, *Callitriche stangnalis* and *Myosotis* sp. The banks show generally a dense riparian vegetation of *Alnus glutinosa*.

Four sampling stations were established in the upper and middle reaches (Fig.1), which altitude ranges from 240 m to 990 m. Stations 3 and 4 are sapared by a water fall, which creates an important ecological discontinuity.

METHODS

For each sampling station we considered 3-4 sub-stations, which lenght varied between 12,4 and 26,1 m. The boundaries of these units, inside where fish capture took place, were set o delineate homogeneous areas in what concerns physical and biogenic characteristics (dimensions of water column, substrate-size class, current speed, aquatic and riparian vegetation, etc.).

Therefore, it was intended that these sud-stations would correspond to a particular habitat, but for a stream reach (station) they were not continuous to avoid disturbance of fish populations in the units next to the ones being sampled.

The aquatic habitat attributes considered, were: average stream width (W), average stream depth (h), maximum stream shore water depth (hB), bank angle (O), dominant and sub-dominant stream substrate channel materials (Subdo & Subna), embeddeness chanel materials (Subem), pool percentage (% Lent), riffle percentage (% Lot), pool quality (Lentqua), streambank negative stability (Bstab), percentage of stream shading (% Shad), riparian quality (Vegqua) and stream side habitat quality (Bhab). Mesurements of more general parameters like pH, temperature (Temp), oxygen (Od), conductivity (Cond), average current velocity (Veloc) and water flow (Flow), were also considered for each point.

Determinations of SUBDO, SUBNA, SUBEM, LENTQUA, BSTAB, VEGQUA and BHAB were based on the ratings defined by Platts et al. (1983), authors that establish for those parameters several classes according with the suitablility for fishes (spawning, egg incubation, habitat for fishes and aquatic invertebrates).

Fish population evaluation was done through electrofishing (D.C.), by a portable generating set (Hans-Grassl) with these technical characteristics: 1200 watts, 300/500 volts and 7/4 ampers. Up and downstream blocking nets were placed in the sub-station sampled. Numbers (N) and biomass (B) were assessed through two multiple-step removal-depletion methods: Lury (1947) and Zippin (1958), respectively based on regression and on a maximum likelihood models. Nº of renovals was comprised between 3 and 7, depending on fishing efficency. The individuals caught were examined for standard lenght and weight measurements, and scales were extracted for age determination. To minimize the effects of temporal changes, the field work in the 4 stations was done in a single week (September 1988).

Tabla 1. Habitat caracterization.

	Station	1				2				3				4		
	Sub-station	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c
ENVIRONMENTAL PARAMETRES	w	3,45	4,40	0,70	3,35	5,30	2,50	5,10	3,20	6,40	1,60	7,65	6,80	6,60	4,80	8,40
	h	0,30	0,45	0,25	0.40	0,30	0,10	0,50	0,30	0,65	0,30	0,50	0,30	0,45	0,50	0,50
	hB	0,15	0,60	0,35	0,60	0,50	0,30	0,90	0,55	0,90	0,55	0,60	0,50	0,75	0,65	0,90
	O	120	80	90	80	140	130	80	80	120	130	140	120	130	120	120
	SUBDO	6	5	5	6	2	5	4	4	5	5	6	5	4	3	4
	SUBNA	2	3	3	4	4	4	2	3	3	3	4	2	5	5	5
	SUBEM	5	5	5	5	2	5	4	5	5	5	5	4	5	5	5
	%Lot	10	5	95	20	5	95	0	0	10	95	0	20	10	80	5
	%Lent	90	95	5	80	95	5	100	100	90	5	100	80	90	20	95
	LENTQUA	2	3	2	4	4	2	5	4	2	1	5	4	5	4	5
	BSTAB	3	3	3	4	2	2	4	4	4	4	3	3	3	3	3
	%Shad	30	70	90	70	5	0	90	80	0	0	0	0	30	80	80
	VEGQUA	2	3	3	3	2	2	4	4	1	1	2	2	3	3	3
	BHAB	8	11	12	13	2	12	12	9	12	12	12	11	11	12	12
	pH	5,6	5,6	5,6	5,6	5,8	5,8	5,8	5,8	6,4	6,4	6,4	6,4	6,3	6,3	6,3
	Temp (°C)	13	13	14	15	14	15	16	16	16	17	20	19	14	15	16
	Od ($mg.l^{-1}$)	10,4	10,4	10,4	10,4	10,0	10,0	10,0	10,0	9,5	9,5	9,5	9,5	9,0	9,0	9,0
	Cond ($\mu mhos.\ cm^{-1}$)	8,5	15,8	15,8	15,8	25,0	25,0	25,0	25,0	30,2	30,2	30,2	30,2	38,9	38,9	38,9
	Veloc ($m.s^{-1}$)	0,0	0,0	0,4	0,1	0,0	0,5	0,0	0,0	0,0	0,2	0,0	0,1	0,0	0,1	0,0
	Flow ($m^3.s^{-1}$)	0,04	0,04	0,04	0,04	0,07	0,07	0,07	0,07	0,04	0,04	0,04	0,04	0,19	0,19	0,9

RESULTS

Only three species were captured : *Salmo trutta fario*, *Leuciscus cephalus cabeda* and *Chondrostroma polylepis polylepis*.

Table 1 describes the values of the parametres used for stream habitat evaluation. Table 2 presents the abundance estimates of the fish population (N and B) refered to m^2, using the two mentioned catch-effort methods.

The small numbers of fish sampled in association with a low catchability efficiency, facts related also with the inefficient stimulation of smooth direct current in water of reduced conductivity, created wide confidence intervals to those estimates. In some cases calculations by the Zippin method were unfeasible, as some removals had zero individuals, and the same happened for chi-square test to determine the goodness of fit between the used removal pattern and the theoretical one, assumig constant capture probability. In spite of that, generally the methods of Lury and Zippin did not differ significantly. B indicates a low fish productivity, but comparable higher in station 4 where is present an assemblage of the 3 species.

Figure 2 shows a histogram of the frequency distributions by year-classes for each population (in st. 4, *S. trutta* and *l. cephalus* were not included as result of the low number observed). If we consider that the smaller fishes are generally sub-

Tabla 2. Estimate values of biomass (B) and density (N) using Lury (L) and Zippin (Z) Methods for each habitat (values refered to n./m2 and g/m2)

		Species											
		S. truta				*L. cephalus*				*C. polylepis*			
Sub-stations		NZ	NL	BZ	BL	NZ	NL	BZ	BL	NZ	NL	BZ	BL
1	a	0,06	0,06	1,11	0,97								
	b	0,16	0,06	—	3,99								
	c	0,09	0,09	3,16	3,16								
	d	—	0,17	—	5,96								
2	a					0,13	0,13	0,50	0,49				
	b					0,00	0,00	0,00	0,00				
	c					0,12	0,11	1,10	1,00				
	d					0,10	0,10	1,44	1,45				
3	a					—	0,03	4.14	0,78				
	b					0,00	0,00	0,00	0,00				
	c					0,14	0,06	0,86	0,79				
	d					—	0,23	—	2,30				
4	a	0,03	0,03	1,48	1,48	—	0,01	—	0,13	—	0,16	—	3,56
	b	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
	c	—	0,01	—	0,42	—	0,02	—	0,46	0,01	0,01	0,14	0,14

stimated (Cortés et al. 1987), the mentioned figure exhibits a relative normal pattern. Meanwhile, the absence of trouts older than 2+ reflects, possibly, the effect of a high level of anglers impact in the area.

The Pearson correlations between N and B with the enviromental variables (Table 3) allow the conclusion that pool-riffle ratio, pool quality and bank angle are the ones more determinant for the population parameters (relations not significant for $P \geq 0.05$, however, very near of this probability level). The vegetation overhang has also some contribution, but a secondary one. The strong micro-spatial variatio (specially B) between habitats (sub-stations) explains why are not significantly different -$P \leq 0.05$- the population estimates along the longitudinal profile - see Table 4 for the analysis of variance.

DISCUSSION

The dificulty in assessing the habitat parameters significantly related with quantitative estimates of fish, depends on two main factors:

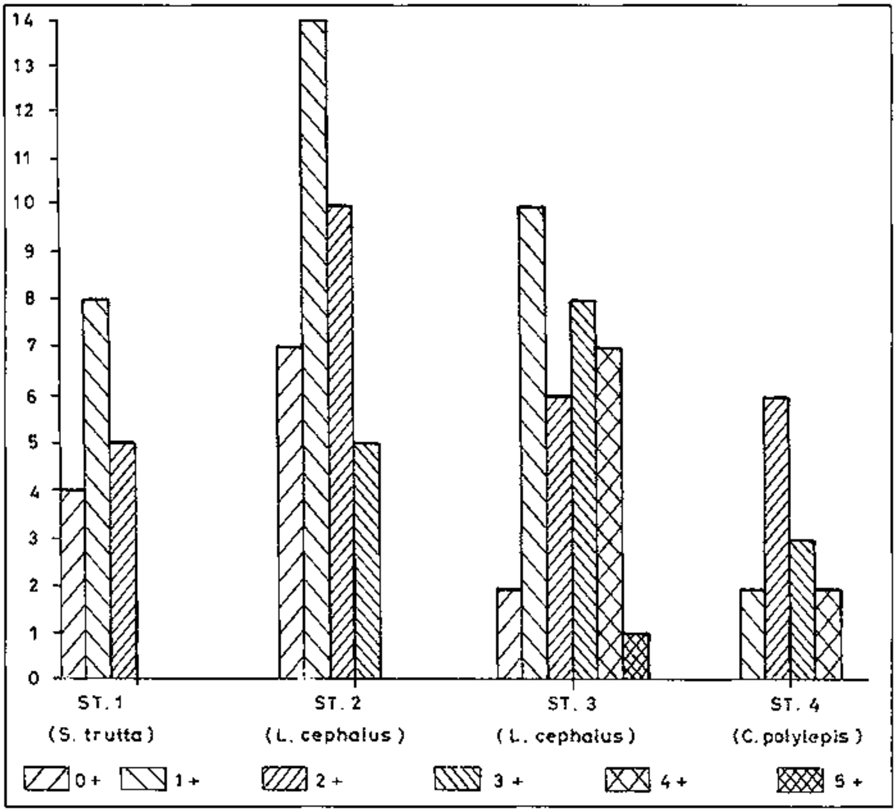

Figure 2. Frequency distributions by year classes of fish populations.

—Low accuracy of the catches generated by an electrical fishing gear in soft waters

—Selection and quantification of the habitat attributes.

About the first aspect, the assumption of constant or randomly fluctuation catchability during the experiment was not possible to accomplish. Mahon (1980) suggests, that for any catch-effort method, the most appropriate way of decreasing error would be to increase the total effort and consequently the portion of fish collected through a higher number of fishings. However, this is not always possible because in small areas the last fishings have often zero individuals. Laurent & Lamarque (1974), concluded also that with low efficiency the achievement of significant stadistical results makes the number of fishing too high to be practical. By other hand, Hartley (1980) observes that continuous exposure to fishing by electric current increases the susceptibility of the fishes in subsequent catches. We also belive, as García de Jalón et al. (1986), that the methods o based on marking

Tabla 3. Pearson correlation coeficients between biomass (B) and density (N) with the environmental parameters

Environmental parameters								
	N	B		N	B		N	B
W	0,243	-0,034	%Lot	-0,453	-0,241	pH	-0,081	-0,320
h	-0,050	0,081	%Lent	0,453	0,241	Temp	0,078	-0,296
hB	0,048	0,068	LENTQUA	0,491	0,237	Od	0,079	0,259
O	-0,183	-0,481	BSTAB	0,035	0,182	Cond	-0,081	-0,311
SUBDO	-0,034	0,281	%Shad	0,011	0,316	Veloc	-0,244	-0,045
SUBNA	-0,147	0,096	VEGQUA	0,289	0,367	Flow	-0,041	-0,008
SUBEM	-0,368	0,195	BHAB	-0,195	0,214			

are not convenient option because they introduce another source of error in the fishes marked. Probably, the replacement of D.C. by pulse current in pure water, as advices Hartley (1980), would improve efficiency, because it produces -if well designed- enough stimulation of nerves at a low potential gradient further from the electrode and thus more uniformly spread.

In what concerns the influence of the habitat on the fish population, the absence of significant correlations between biotic and abiotic variables, can be explained by the bias introduced with the inclusion of several species in the study (each one accounting for significant proportion of variability), subjective evaluation of the environmental parameters and low number of sampling units. Better descriptions of micro-habitats and fish locations can be probably achieved by a transect desing combined with an habitat sampler (Platts & Partridge, 1983; Rinne, 1985).

Tabla 4. Analysis variance of biomass (B) and density (N); the source of variation concerns the 4 sampling stations.

VARIABLE: B	Núm. 15	r: 0,615		r^2: 0,379	
Source	Sum-of-squares	Df	Mean-squares	F	P
Stations	19,350	3	6,450	2,234	0,141
Error	31,764	11	2,888	-	-
VARIABLE: N	Núm. 15	r: 0,0089		r^2: 0,008	
Source	Sum-of-squares	Df	Mean-square	F	P
Stations	0,001	3	0,000	0,029	0,993
Error	0,072	11	0,007	-	-

Anyway, we think that the method used in the Olo is cost-effective and reliable, but should envolve a higher number of habitats. Besides, because each species has specific habitat preferences, they should be assessed separetely.

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